FORESTRY

FRDA REPORT 102

ADVANCES IN SAWMILL TECHNOLOGY

compiled and edited by
G.R. MIDDLETON*

FOREST RESOURCE DEVELOPMENT AGREEMENT

Canada

BC

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ADVANCES IN SAWMILL TECHNOLOGY

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by

G.R. Middleton

PROCEEDINGS OF A FORINTEK CANADA CORP. SEMINAR

sponsored
by

THE CANADA - BRITISH COLUMBIA FOREST RESOURCE
DEVELOPMENT AGREEMENT

in cooperation with

THE LUMBER MANUFACTURING ASSOCIATIONS
OF BRITISH COLUMBIA

October 1989

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PREFACE

Forintek Canada Corp.'s 1988-89 research program achieved important developments in sawing, saw control, moisture sorting and incising for treating and seasoning of lumber. These achievements, along with the results of mill performance tests of camera scanners for computer-optimized log bucking and of curve sawing equipment, were reported to Forintek's member companies through a series of seminars, the proceedings of which are provided here.

The seminars took place in Prince George, Williams Lake and Kelowna, B.C., June 8, 13 and 15, 1989 respectively.

ACKNOWLEDGEMENTS

Forintek Canada Corp. thanks the Canada-British Columbia Forest Resource Development Agreement for their financial support of the seminar and the publication of these proceedings. Thanks also to the Lumber Manufacturing Associations of British Columbia for their support and help in managing and advertising the seminar venues.

TABLE OF CONTENTS

	PAGE
PREFACE	i
ACKNOWLEDGEMENTS	ii
KEYNOTE ADDRESS - M. HEIT	1
MOISTURE SORTING - S. WARREN	5
BENEFITS OF MOISTURE SORTING - C. FANCY	21
CAMERA SCANNERS FOR COMPUTER OPTIMIZED BUCKING SYSTEMS - D.R. GILES	45
LUMBER INCISING - D.C. WALSER	63
INCISING FOR DRYING - J.F.G. MACKAY	66
INCISING/PRESERVATION - P. MORRIS	72
TRAINING AND EDUCATION - J.F.G. MACKAY	92
CURVE SAWING, CANT OPTIMIZATION AND LOG ROTATION - S. WANG	96
CURVE SAWING - JOHN HARDS	117
TESTING A NEW CIRCULAR SAW GUIDE SYSTEM IN A LARGE PRODUCTION SAWMILL - E. KIRBACH	129
A SAW CONTROL SYSTEM - S. WARREN	143

KEYNOTE ADDRESS

by

M. J. Heit

Senior Program Director

Forest Development

Forestry Canada

Pacific and Yukon Region

KEYNOTE ADDRESS

by

M. J. Heit

This seminar is part of a series of regional seminars and it is a good example of Forestry Canada and FRDA funding working in collaboration with Forintek and the B.C. Lumber Manufacturers' Associations to bring practical research and development to you.

FRDA's objective has been aimed at security of supply issues. Our normal way of "Fixing" this has been to increase timber yield in the field through improved silivicultural practices. The traditional methods of planting, brushing and weeding, thinning and fertilization have made a significant impact to bring about security of supply. In British Columbia to December 31, 1988 FRDA expenditures totalled $193 million dollars resulting in employment of over nearly 839,000 person days and in approximately 105,000 hectares of NSR land being restocked.

These "new volumes", however, will offer supply relief only in regions of the province where there is sufficient volume of mature timber present to sustain current harvest levels. In other regions, because of poor age class distribution or over cutting, this increased supply will not pay real dividends in merchantable timber supplies for some years down the road.

This seminar takes a different tact. The more product (both physical and

value wise) we get out of a tree, the fewer trees we use for a given amount of output. In this sense, an efficient sawmill is also about security of supply. Increased utilization and conversion at the mill end is as important as planting trees. Forintek's research program produced important developments last year in sawing, saw control, moisture sorting and incising for treating and seasoning. Rapid field testing and technology transfer has been made possible by funding from Forestry Canada and the industry Forintek Partnerships. These seminars, through presentations from Forintek Staff and co-operating sawmill production people will provide you with an up-to-date report on these very exciting projects.

Forestry Canada, perhaps through the next FRDA Agreement, will be considering a technology transfer program which is aimed at mill efficiency and added value. As supply gets tighter through land alienation, fire, insects and disease and environmental constraints industry must consider increased utilization, development of new products and improved processing. We will address these issues in future programs. Using the current FRDA, Forestry Canada has expanded lands traditionally in forestry by funding reforestation activities on Indian reserves, and on private lands. In future programs, we hope to focus on under-utilized resources in B.C., such as hardwoods, decadent cedar and hemlock, salvage wood, wood from commercial thinning, etc.

The B.C. forest industry has maintained its competitive position largely

by practicing cost reduction and productivity improvement. Reduced timber supply threatens that method of maintaining productivity. Future profits will have to come from producing a higher value product and from technological improvements in conversion processes that emphasize higher recovery rather than increased throughput. Sawmills with low recovery factors will increasingly find no place in our industry where supply is virtually 100% committed. It is not right for the public purse to allocate scarce funds to increase yield at the planting stage, if some operations are still not maximizing utilization at the milling stage. If we are going to look at good forest management, security of supply activities have to be intensified all the way from seed to sale.

With that I am sure you are very anxious to here about new flexible saw guides, camera scanners, and moisture sorting and all the other good things you will hear about today. Every good wish for a very productive seminar here, and I thank you for this opportunity to be able to address a few opening remarks to you. Thank you.

MOISTURE SORTING

by

Sita Warren

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MOISTURE SORTING

by

Sita Warren

This discussion will focus on mill results which deal with moisture distributions and their importance. Sorting green lumber into moisture content (MC) classes before kiln drying is an essential ingredient in improving lumber grade, reducing drying time and energy costs and increasing kiln capacity. In order to sort by moisture content, data on MC distribution must be available to make the following decisions:

1) To determine the drying rates of the species mix.
2) To establish cut off points if there is an on-line moisture meter.
3) To provide data relating drying rates of a mixed kiln charge to determine which species is not meeting MC standard when dried to 16%.

In this study 4 sites were sampled, to show the effect of the natural resource on the types of moisture distribution:

1) Finlay Forest Products (MacKenzie)
2) The Pas Lumber (Prince George)
3) Westar (Castlegar)
4) Blue Ridge (Whitecourt, Alberta)

Specimens were wrapped in plastic and sent to the laboratory for analysis.

From each board, two samples were cut, weighed in green condition and then ovendried. Moisture contents were calculated and frequency distributions plotted. Species identification of each specimen was performed using a light microscope.

RESULTS AND DISCUSSION

Site 1. Finlay Forest Products (MacKenzie, B.C.)

Samples from the site consisted of SPF mix. Each specimen was identified in the mix for moisture content and species. The MC ranges from 25% to 225%, yet the average is 68%. The quantity of pine, spruce and fir were 16%, 39% and 45% respectively.

The samples were separated into 2 kiln charges, below 45% MC (A) and above 45% MC (B). The two charges were dried to 16%. The kiln drying times were 19 and 38 hours.

The kiln charge which was under 45% MC consisted of 11% pine, 71% spruce and 17% alpine fir. Charge B (over 45% MC) contained 18% pine, 10% spruce and 62% alpine fir. The perception commonly held that all alpine fir boards have a high moisture content is false because kiln charge (A) contained 17% alpine fir under 45% moisture content.

Each board was weighed after kiln drying to calculate the oven dried MC

The results showed that the percentage of wets in charge A and B was 6% and 8% respectively. This preliminary result showed that alpine fir can be dried with spruce and pine, if the 3 species are sorted according to moisture content class. The economic savings to many mills can be substantial because alpine fir logs are sorted, stored, and processed separately.

Site 2. Blue Ridge (Whitecourt Alberta)

The average moisture content of the SPF mix is 54%. Spruce which is considered to be the species with the lowest MC is showing samples with 115% MC. The average MC of the pine in this mix was 78%. The average for alpine fir was 97%. These two moisture distributions show that both pine and alpine fir contain a large percentage of wet wood. The wet pine in the mix did not meet moisture content standards. When these two SPF sites are compared, one can clearly see that not only the average MC varies but also the percentage of pine, spruce and fir in the kiln charges.

Site 3. The Pas Lumber Co. (Prince George)

The samples from this site were Alpine fir which is processed separately at this mill. The logs are stored up to 3 months before they are sawn into lumber. The average MC for the first series studied (Figure 1) was 65% and for the second series which was sampled one month later (Figure 2)

was 60%. The minimum average MC for alpine fir in the Prince George area is 55% (Figure 3) and the maximum 65%. The initial moisture content for alpine fir differs from one location to another.

Site 4. Westar Timber (Castlegar, B.C.)

Westar Timber has increased its production of interior hemlock and very little data is available on the initial moisture content which is an important factor in the kiln drying process (Figure 4). Figure 5 shows the frequency distributions of the overall samples for Douglas Fir/Larch. These samples were then broken down into various dimensions: 2x4, 2x6, 2x8, 2x10 and 2x12 (Figures 6-10). The specimen cut from 2x10 had the lowest initial MC. The reason for this is that the 2x4 boards are cut from smaller diameter logs and consist mostly of sapwood while the 2x10 is cut from larger diameter logs which is mostly heartwood.

The moisture distributions from these sites provide good examples of the importance which should be placed on knowing the characteristics of the natural resources. An intimate knowledge of this aspect will lead to better moisture sorting, efficient drying, minimize degrade, and cut down planer downtime.

Examples where Forintek has installed laboratory models of the moisture sensor for sorting are:

a) Weldwood of Canada (Williams Lake): The first mill trial was conducted at this plant and showed that the economic benefit derived through sorting was $8.50 per thousand board feet. This figure was calculated by the plant and is a very conservative one. This mill used about 35% as a cutoff point for sorting.

b) West Fraser Mill (Williams Lake): This plant sorted above 20% and below 20% MC. The lumber under 20% was planed and was not kiln dried. A saving of $17.00 per thousand was realized at this plant.

c) Westar (Castlegar): Douglas fir/larch mix was sorted at this plant and the cut off point was above 45% MC and below 45% MC. An economic saving of $20.00 per thousand board feet was realized at this plant. This included grade, energy saving, planer downtime, and a saving in kiln drying time.

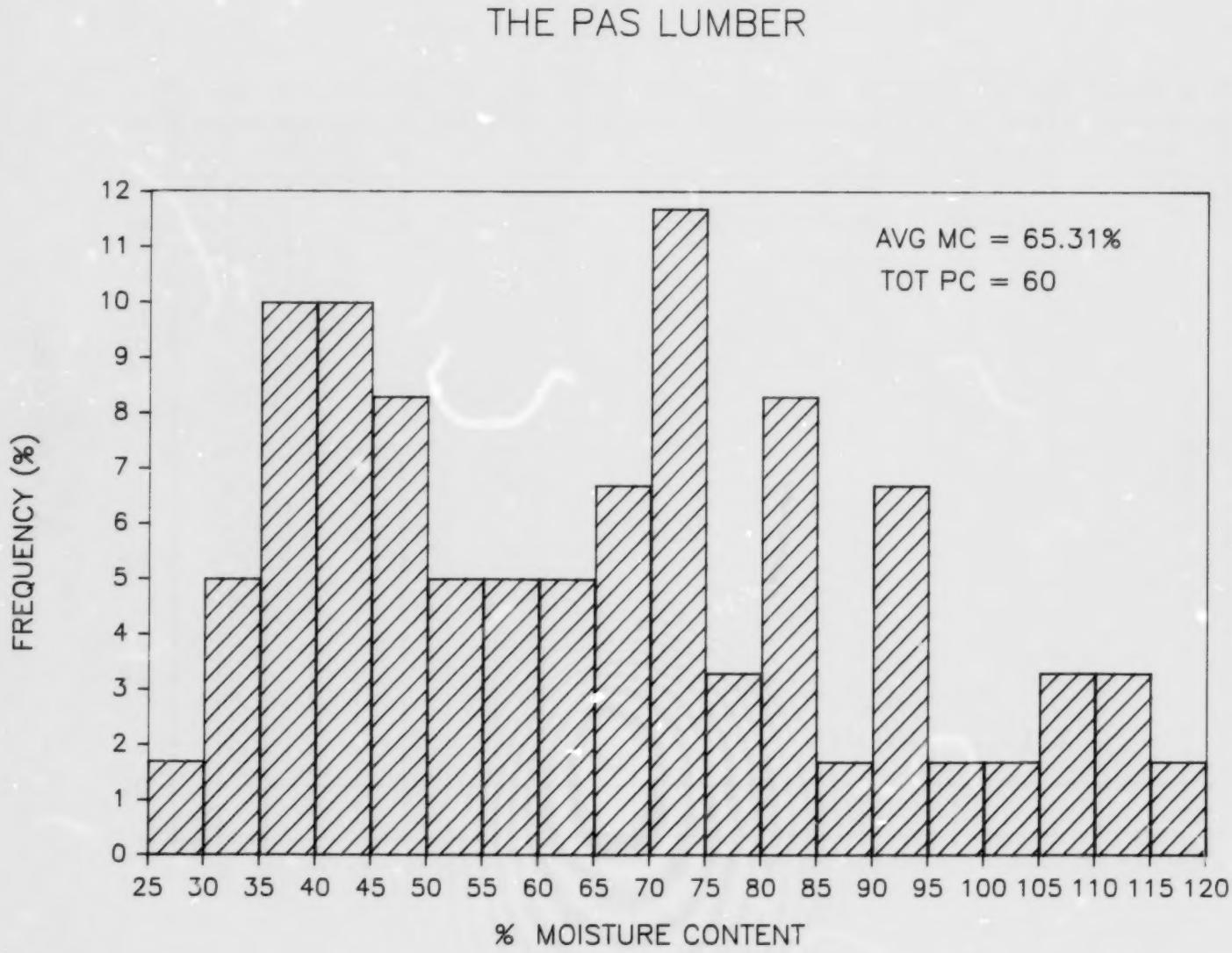

FIGURE 1 Balsam/Fir Moisture Content Distribution (1" x 2" x 4")

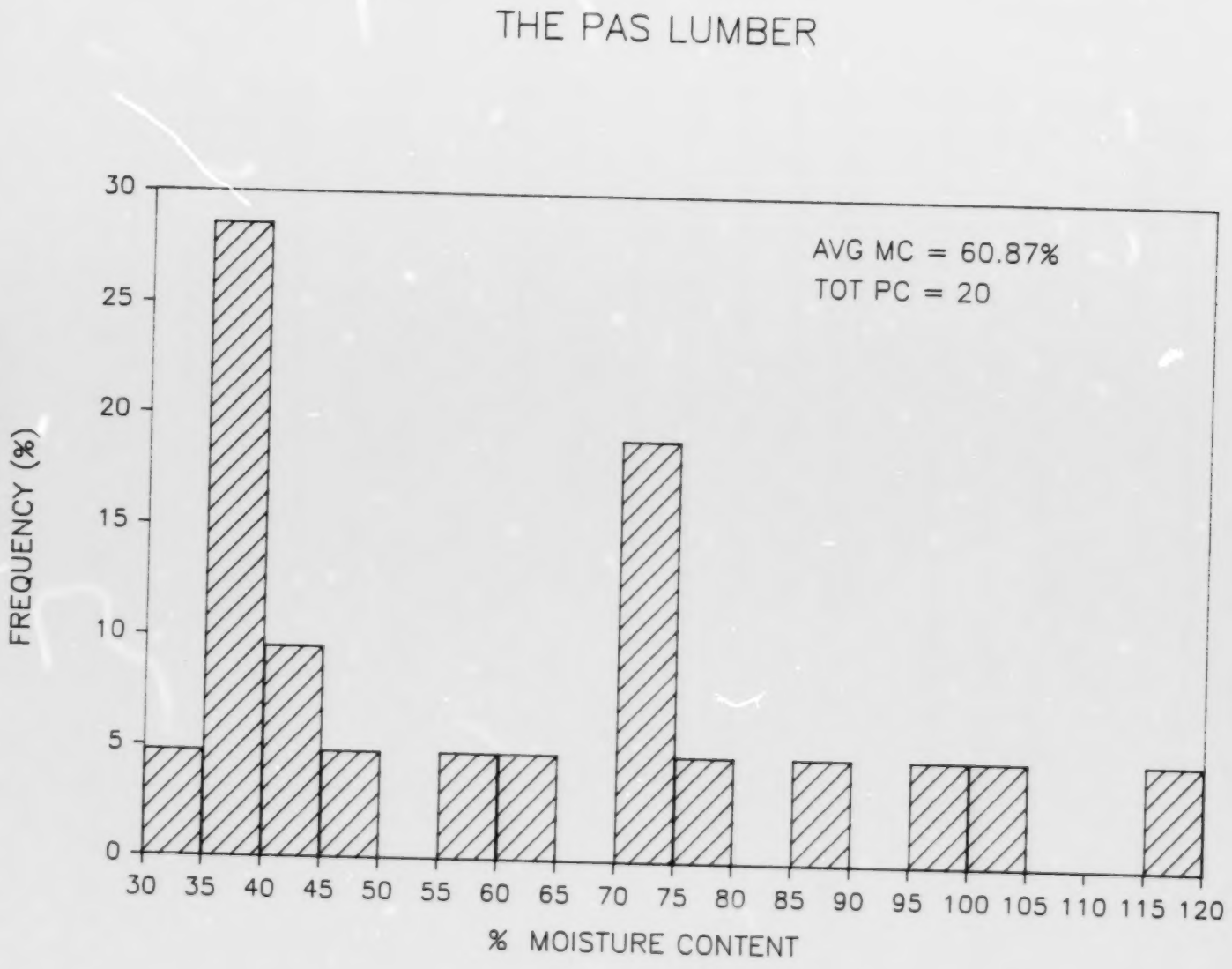

FIGURE 2 Balsam/Fir Moisture Content Distribution (1" x 2" x 6")

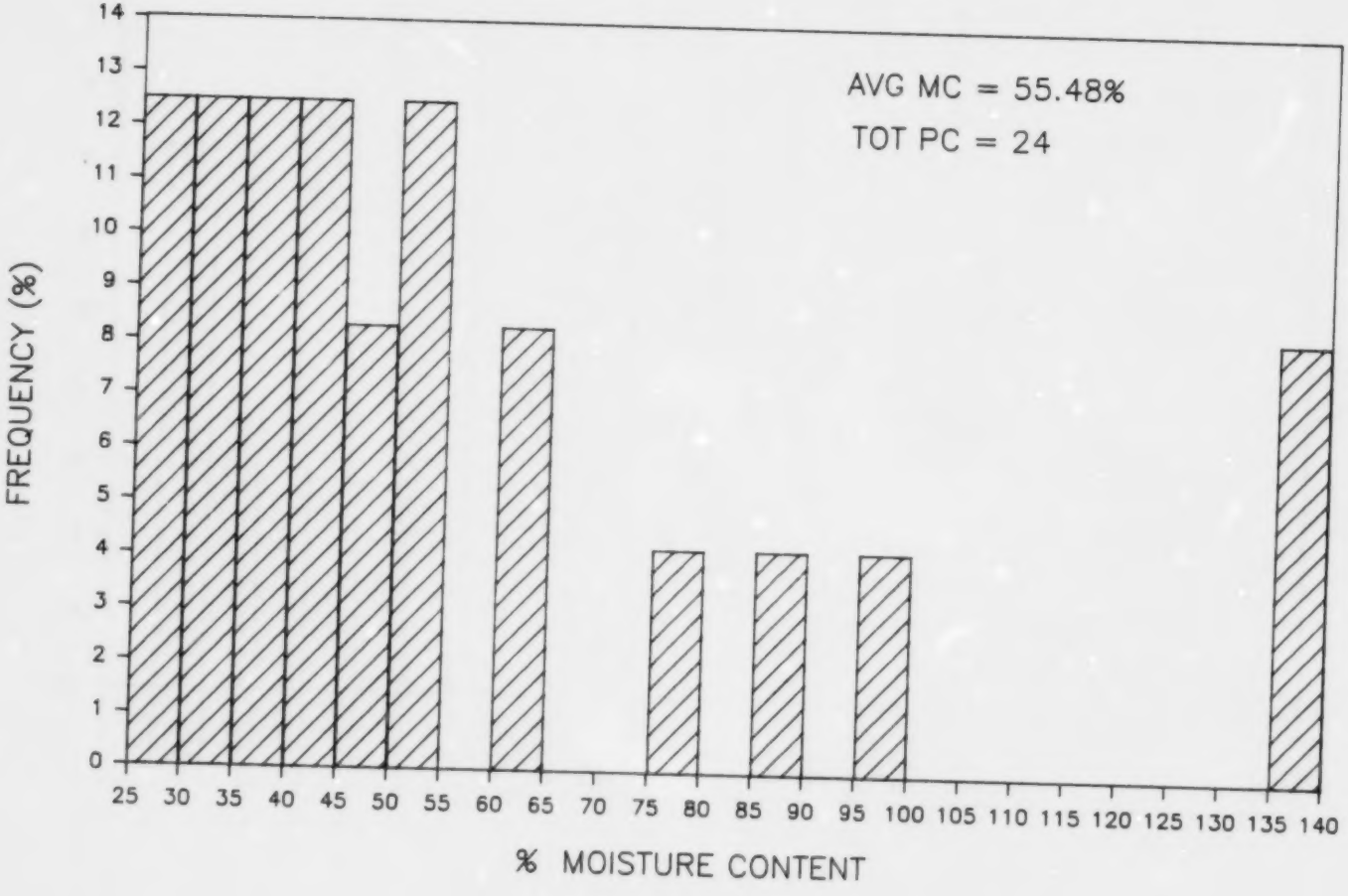

FIGURE 3 Balsam/Fir Moisture Content Distribution (1" x 2" x 8")

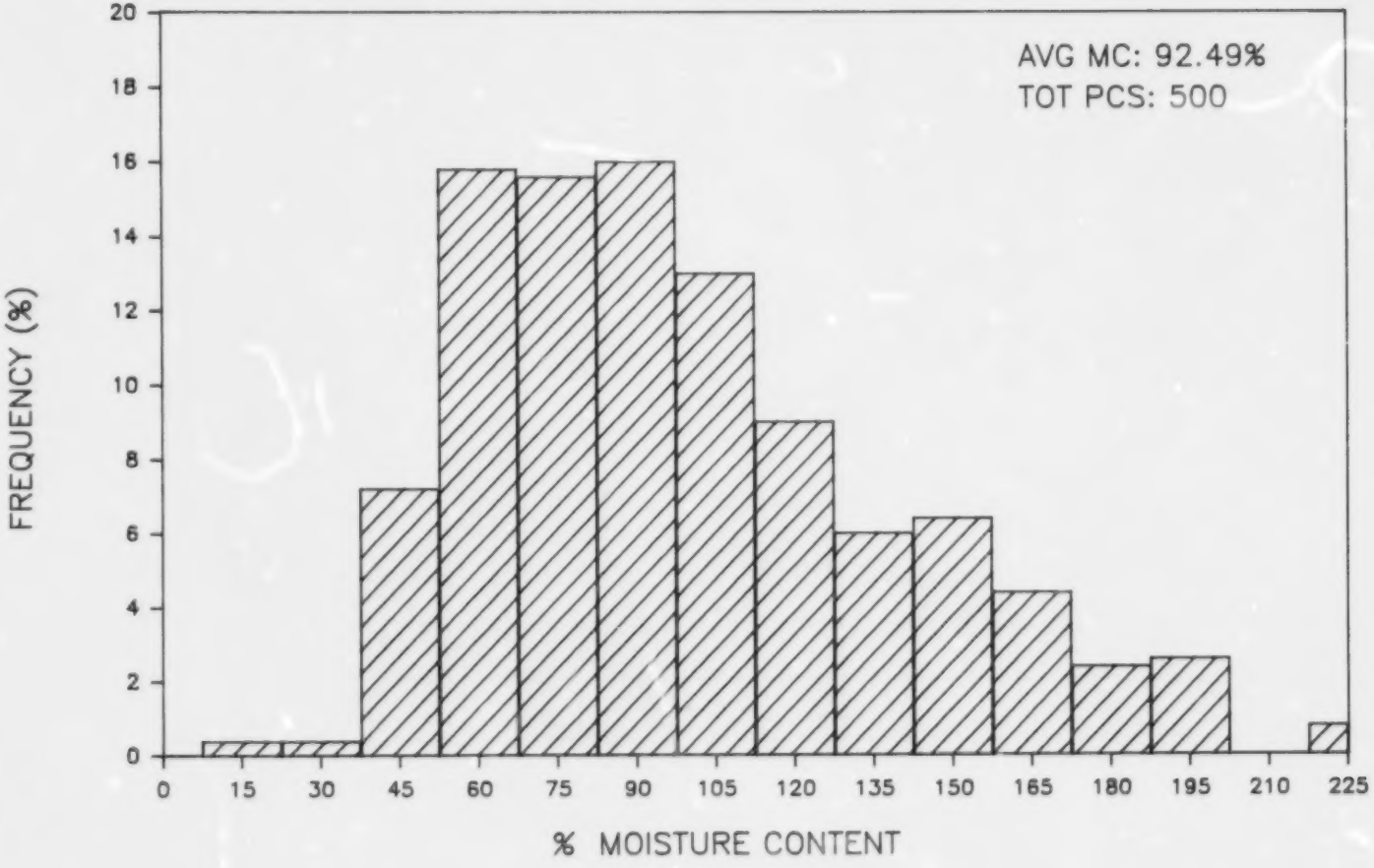

FIGURE 4 Interior Hemlock Moisture Distribution

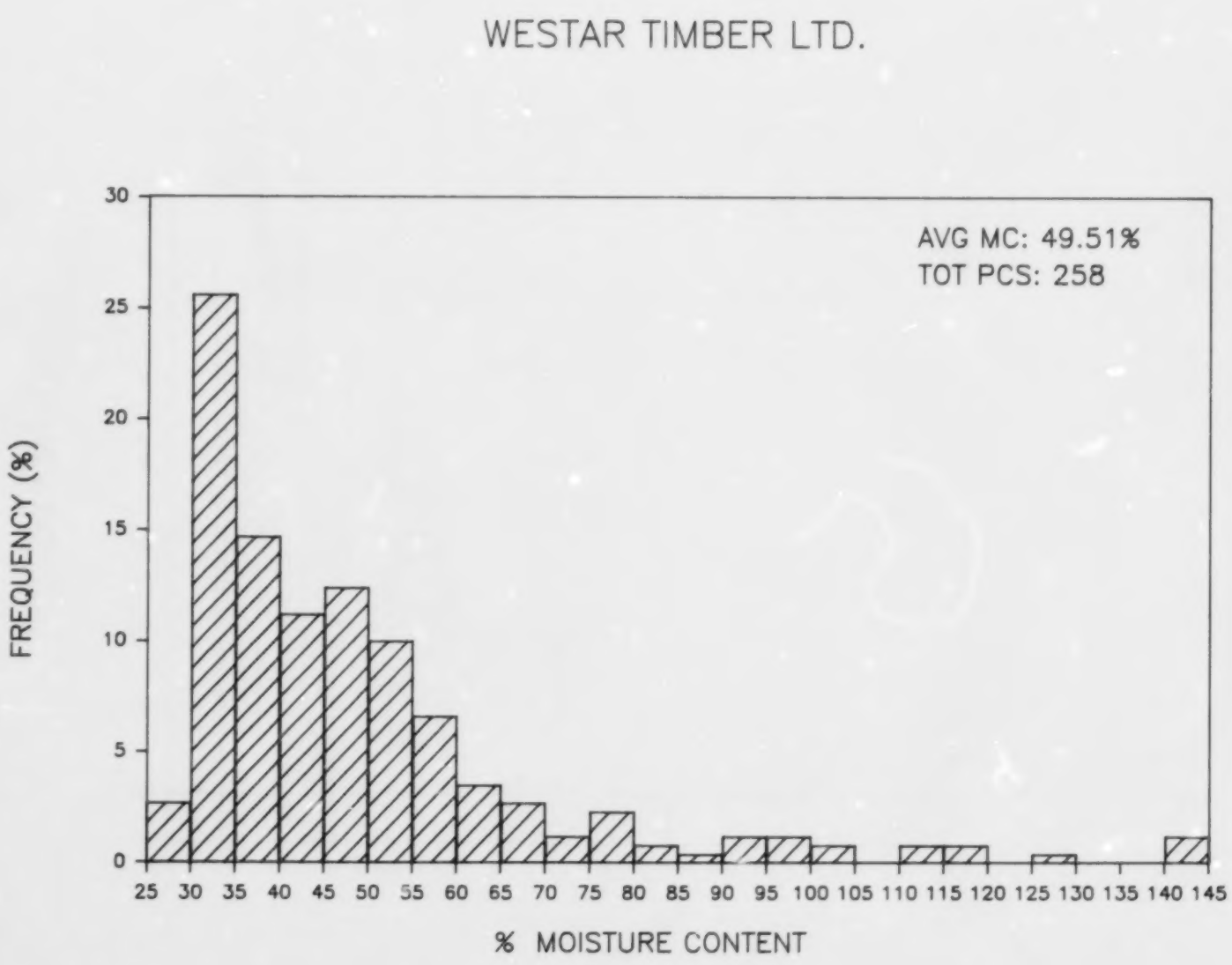

FIGURE 5 Moisture Content Distribution (Douglas-fir & Larch)

WESTAR TIMBER LTD.

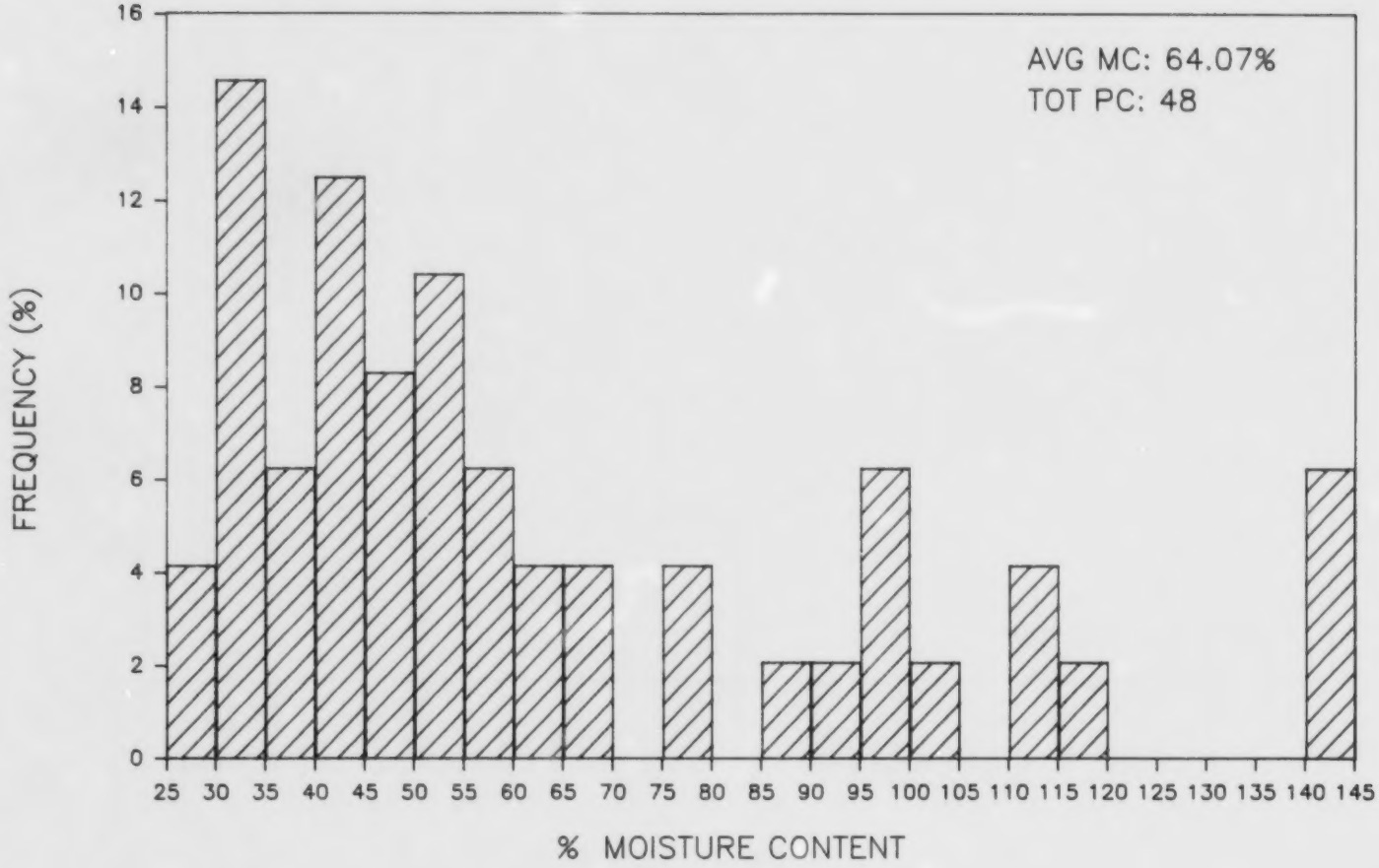

FIGURE 6 Moisture Content Distribution (2" x 4")

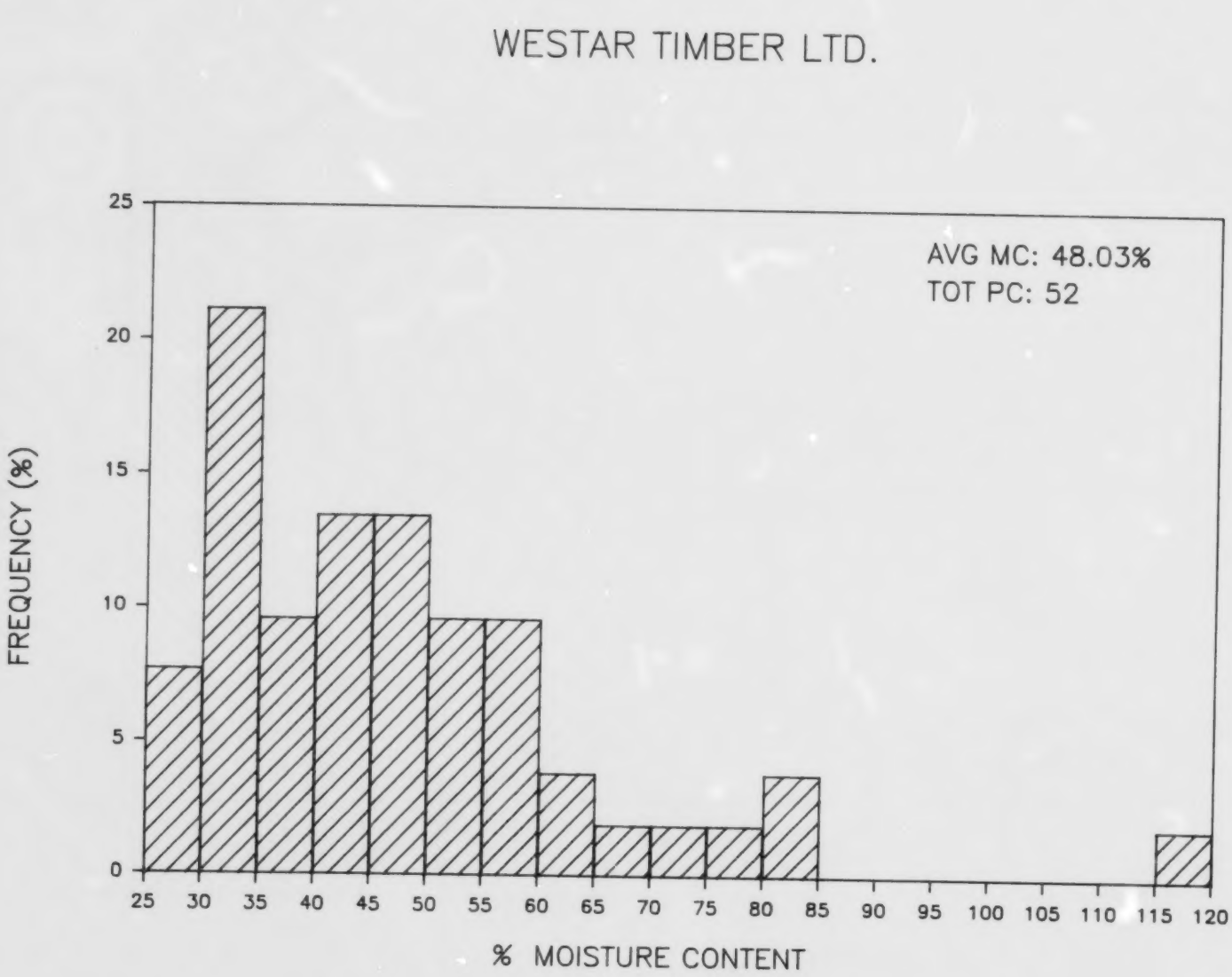

FIGURE 7 Moisture Content Distribution (2" x 6")

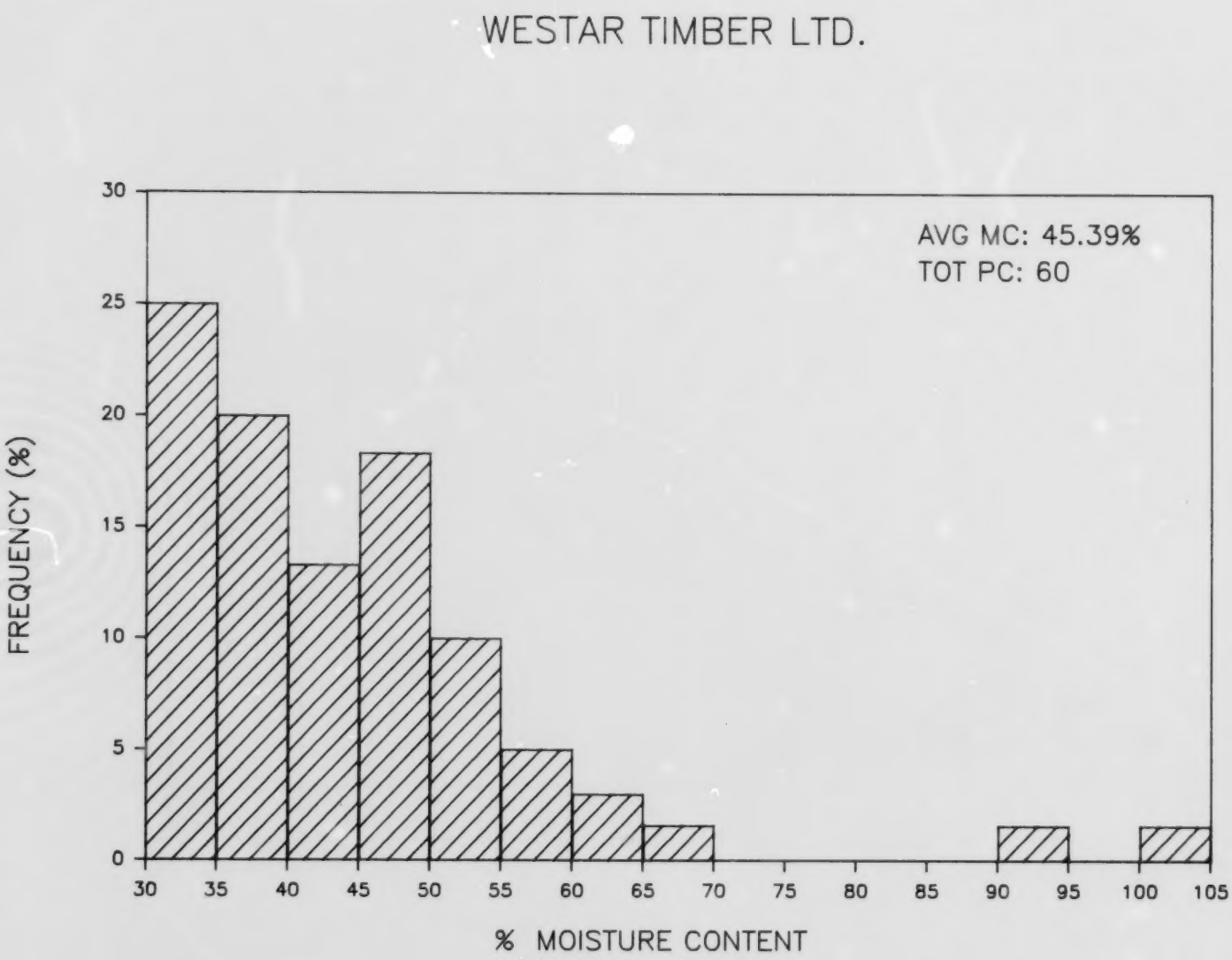

FIGURE 8 Moisture Content Distribution (2" x 8")

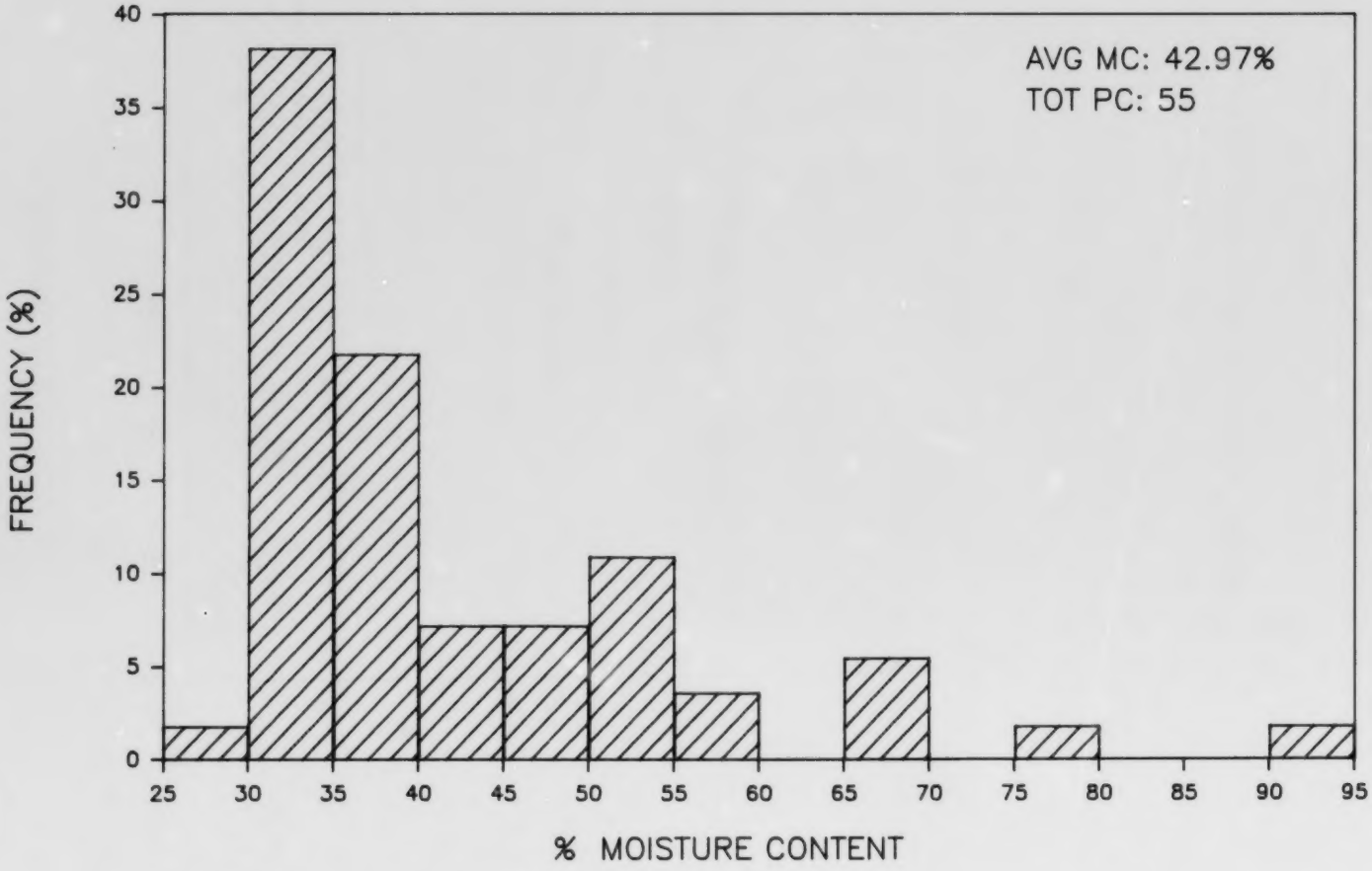

FIGURE 9 Moisture Content Distribution (2" x 10")

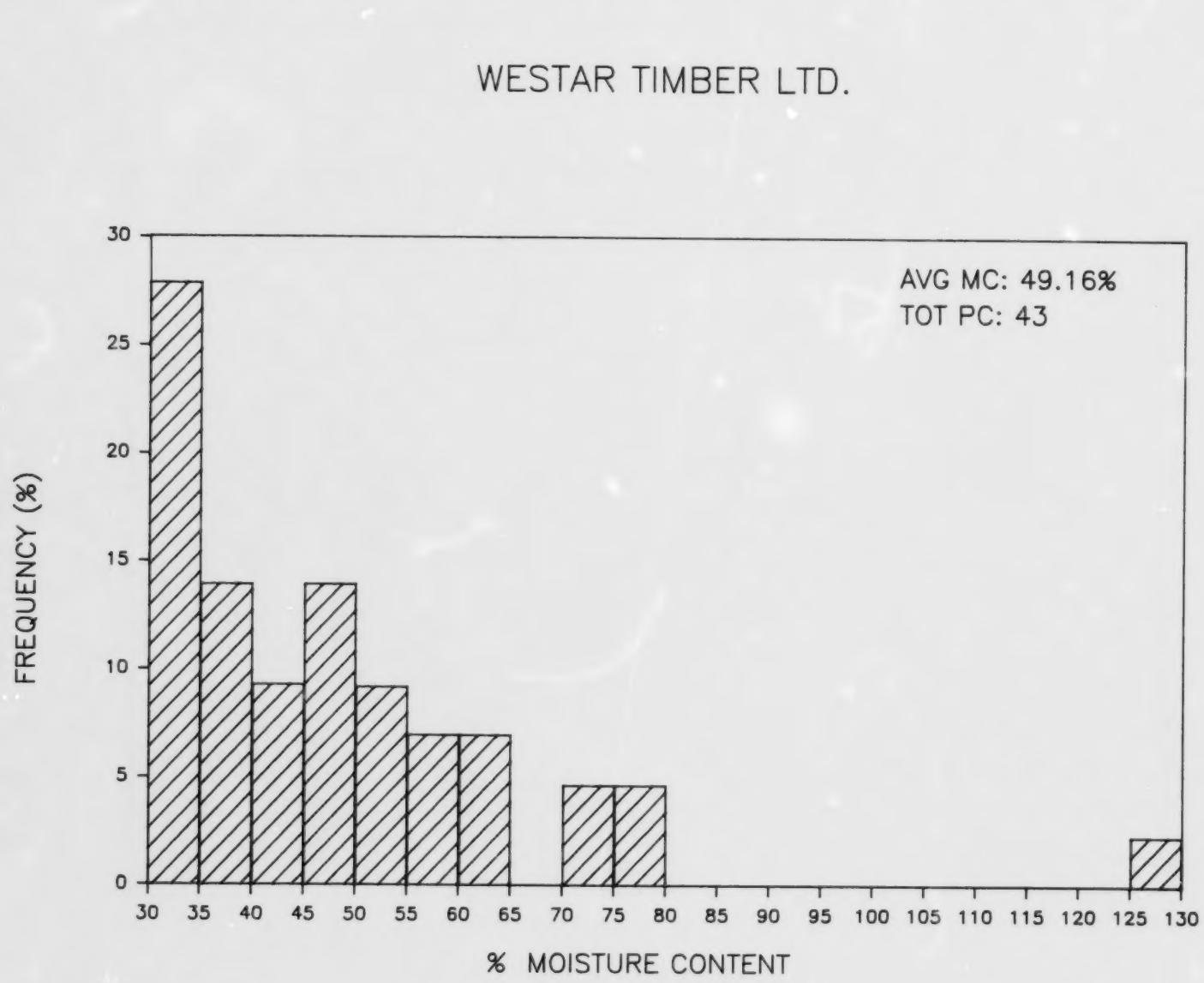

FIGURE 10 Moisture Content Distribution (2" x 12")

BENEFITS OF MOISTURE SORTING

By

C. Fancy

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BENEFITS OF MOISTURE SORTING

by

Chris Fancy

My presentation today will focus on the benefits of moisture sorting. lumber. I will start with an overview of our system, present some moisture content data which will include some of Forintek's information as well as our in-house information, and then follow by discussing opportunities offered by moisture sorting.

Our mill produces approximately 200 million board feet a year of Spruce-Pine-Fir (SPF), Douglas-fir and Hemlock. The SPF and Douglas-fir each constitute about 35% of our log mix, and Hemlock makes up the remaining 30%. The SPF species group has 25% Alpine Fir.

Our sorting system is located downstream from the Chip-N-Saw line, between the trimmers and bin sorters. The line speed underneath the scan zone is between 180 - 225 feet per minute which is equivalent to 60-75 lugs per minute. The bin sorter has 45 bins and we have dedicated 10 bins for wet wood sorts. Five of these bins are for 2X4's of varying lengths, and the other 5 bins are for 2X6's. The wet-sorted lumber is dried separately in one of four gas-fired, computer-controlled kilns, each of which has a capacity of 300 thousand board feet.

Figure 1 shows a general view of the sorting system. The moisture sensor

system supplied by Forintek is the aluminum square frame in the middle. The catwalk on the right was used during start-up for making installation adjustments. This is a side view of the system, showing the lumber flowing from left to right. The lumber first passes underneath the two heaters, and then passes underneath three temperature sensors which are attached to the right side of the aluminum frame.

The large steel frame system shown in Figure 2 provides protection for the two radiant heaters which are fragile. Without this protection, they can be bumped by bowed wood and short-circuit. The two heating elements, located between the protective frame, run parallel to the lumber flow. They are set 2 inches above the lumber on the line. The protective frame is set 1 inch above the lumber. The two temperature sensors shown on the right in Figure 3 are lined up with the heaters directly in front of them; the temperature sensor on the left is aimed at the unheated area of a board. Figure 4 provides a close-up view of a temperature sensor lined up with a heater on the right, and the cold reference sensor on the left. The operating principle for determining the moisture content is based on the difference in temperature between the heated zone and the unheated zone. Wet wood heats up at a slower rate than dry wood and thus the difference between an unheated zone on the left, and the heated zone on the right, is very small if the wood is wet; and conversely very large if the piece is dry. Sorting is performed using the measured difference in temperature.

Figure 5 shows the computer system supplied by Forintek. On the bottom is the PC which has the operating program. Immediately above the PC is the

communications interface which takes signals from the three temperature sensors. The computer processes these signals and determines moisture content using criteria that is based on Forintek's moisture content distribution work.

A close view of the display on the monitor in Figure 6 shows a column with the word "Bell" appearing on several lines. The word "Bell" indicates that a board does not meet the minimum moisture requirement to be considered dry. Thus, it is sorted out as wet. We have a high percentage of wets but not for all widths. Forintek's research shows that the wettest boards are predominantly 2X4s and 2X6's, so we don't sort the wider sizes by moisture content.

The Programmable Logic Controller, or PLC, is shown in Figure 7. It takes the signal provided by the Forintek system along with information from our size measuring system (Figure 8) and makes the sort decision. Once the PLC has all this data, it compares it against what we have defined as valid sorts. Valid sorts are defined by using the PLC input panel shown here in Figure 9. The PLC is set up so that we can pick any length, width, and thickness combination and define it as a wet sort or a dry sort.

If a 2x4 or 2x6 board is wet, the PLC issues a signal to the end-spray system (Figure 10) down-stream from the measuring system. The board is then sorted into the correct bin. Figure 11 shows the end result: on the right, the painted, wet-sorted boards; and on the left, the unpainted dry-sorted boards.

The Forintek system started up without a flaw. Forintek has to be commended for its program which works very well.

The flow chart in Figure 12 shows the flow of information between the components of the moisture system. Data from the temperature sensors are fed to the Forintek PC. The wet or dry signal is fed from the Forintek system to the PLC, which also collects the length, width, and thickness data. A highlight of this system is that the PCL automatically shuts the heater off after 30 seconds if the line is not moving. This innovation is credited to Bob Williams, our Electrical Supervisor, and his crew. This feature eliminates ignition problems with lumber kept under the heat source for a long period of time. The PLC keeps checking to see if the line is moving and once it is moving again the heaters go back on. The PLC then checks if the heaters are active because they could be down due to a short circuit. If the heaters are inoperative, all the wood that would have otherwise have been found wet would be sorted into what we call Species One sort designation - the default sort designation which is redefined as a dry sort designation when the moisture system is in service. If the PLC has received a wet signal from the Forintek PC, the piece would continue to its wet sort bin down the sorter, while dry pieces would drop into a dry sort bin. The wet wood is given a Species Two destination. Before sorting to this designation, the PCL asks if the board's length, width, and thickness measurements are defined as a valid sort. The reason for this is that the "wet" wood must be a 2X4, or 2X6 to be valid. If it doesn't pass that test, (its a 2X8, 10 or 12) it will go

through the default Species One sorts.

Finally, the PLC will check that a wet sort bin is available. If yes, a signal will be sent to the solenoid spray before being sorted; if no, the board will be routed to a Species One bin.

Next we will look at initial moisture content data. Figure 13 was extracted from Forintek's data. Hemlock and Douglas-fir data are graphed together so they can be compared. Hemlock presents more drying problems because of the very broad initial moisture distribution; while D-fir, which shows a tight distribution, dries very well. Drying time for Hemlock was 44 hours versus 34 hours for Douglas-fir. SPF has a drying time of around 39 hours which falls between that of D-fir and Hemlock. Given the 25% Alpine Fir in our SPF, its moisture distribution is going to look very similar to that of Hemlock. But we expect, as was pointed out in the previous talk, that the wet sort will not be limited strictly to Alpine Fir - Pine and Spruce will produce wets also.

Now we will consider the kiln-dried moisture distribution data that was collected in our mill by our planer Quality Supervisor for 2x4s, and 2x6's. Table 1 shows the moisture content data for both sorted and unsorted material. You can see that the Douglas-fir has an average moisture content of 13.5%, and a very low wet percent. Hemlock, on the other hand, has a high component over 19% for 2X4s and to some extent for 2x6's.

Table 2 shows sorted material. On the graph for Hemlock (Figure 14) the wet sort is the line with box points and it is compared to the common dry sort, with cross points. The common dry sort is taken on the line from which the wet material is sorted plus the unsorted material from the second lumber sorter. The distributions are very similar. The little bumps in the graph are attributable to common dry stock. Looking just at this data we can see that there is an advantage to using the moisture system, and reducing the 19% or greater component.

Drying times for these two sorts - the wet sort and the common/dry sort, were very similar - both averaged 44 hours. But the difference becomes very clear when the over 19% component is considered. The dry sort had 17.1% of its pieces with over 19% MC, versus 5.8% for the wet sort.

Now we will move on to discuss the opportunities that exist with moisture sorting. The Forintek system is very capable of differentiating between wet wood and dry wood, and it is flexible enough to suit different needs in terms of species, sawmill parameters and kiln characteristics. Controlled moisture distribution is an obvious benefit, because keeping the 19% and over content down has a positive impact on the customer. High over content results in claims and lost customers.

One of the tangible benefits of moisture sorting is reduced planer down time. Right now we have about 40 minutes of downtime per 16 hours of operation that is due to drying defects. That downtime alone is worth about $117,000 so gains can obviously be made there. Energy saving in the

kilns is another benefit. Fuel costs for our gas-fired kilns are about $75,000 a month. If we achieve a 10% reduction in drying time by sorting out pure dries and running that dry stock through the planer, savings at the kiln would equate to about $23,000 a year. Similarly a 20% reduction would be worth $68,000 a year.

We previously sorted out our small Alpine Fir, 16 inch and under, from the Spruce and Pine out in the woods. Since we installed the moisture sorter system we have stopped sorting our logs and at a conservative estimate that should save about $60,000 a year. We have not yet quantified the grade outturn, but if we make a one point improvement from a No. 3 to a No. 2 and better, it will be worth about $120,000 annually.

In summary, potential gains on an annual basis, can range from $60,000 to $240,000, on the conservative side, and possibly up to $500,000. These potential benefits make a very short pay back period for the commercial moisture sorter which costs around $85,000.

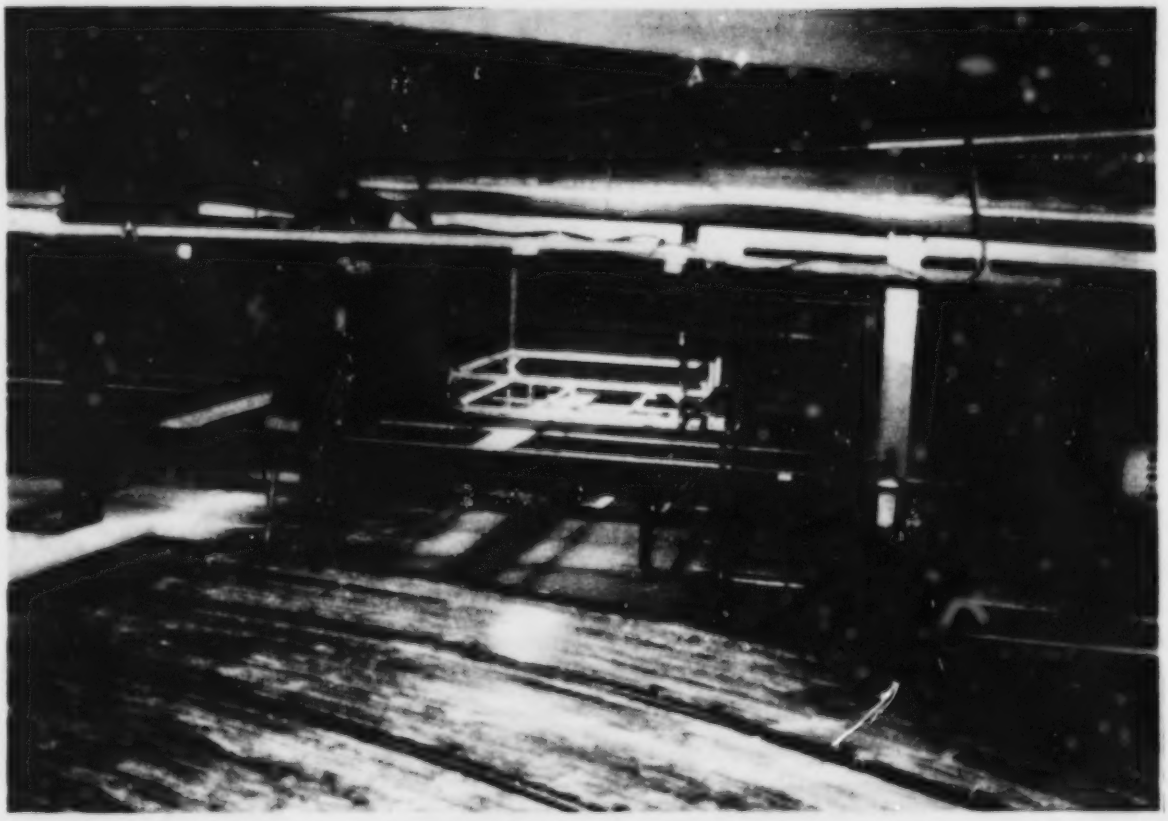

FIGURE 1 General view of sorting system

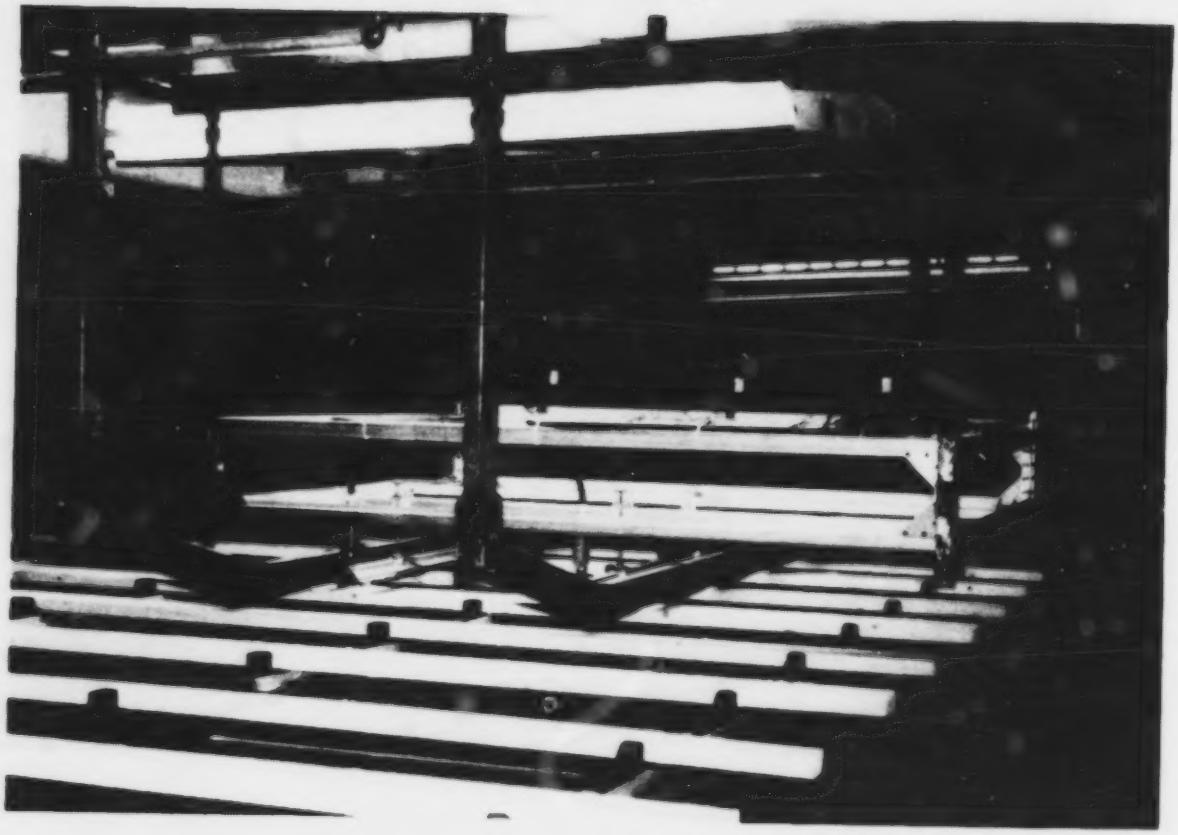

FIGURE 2 Protective frame

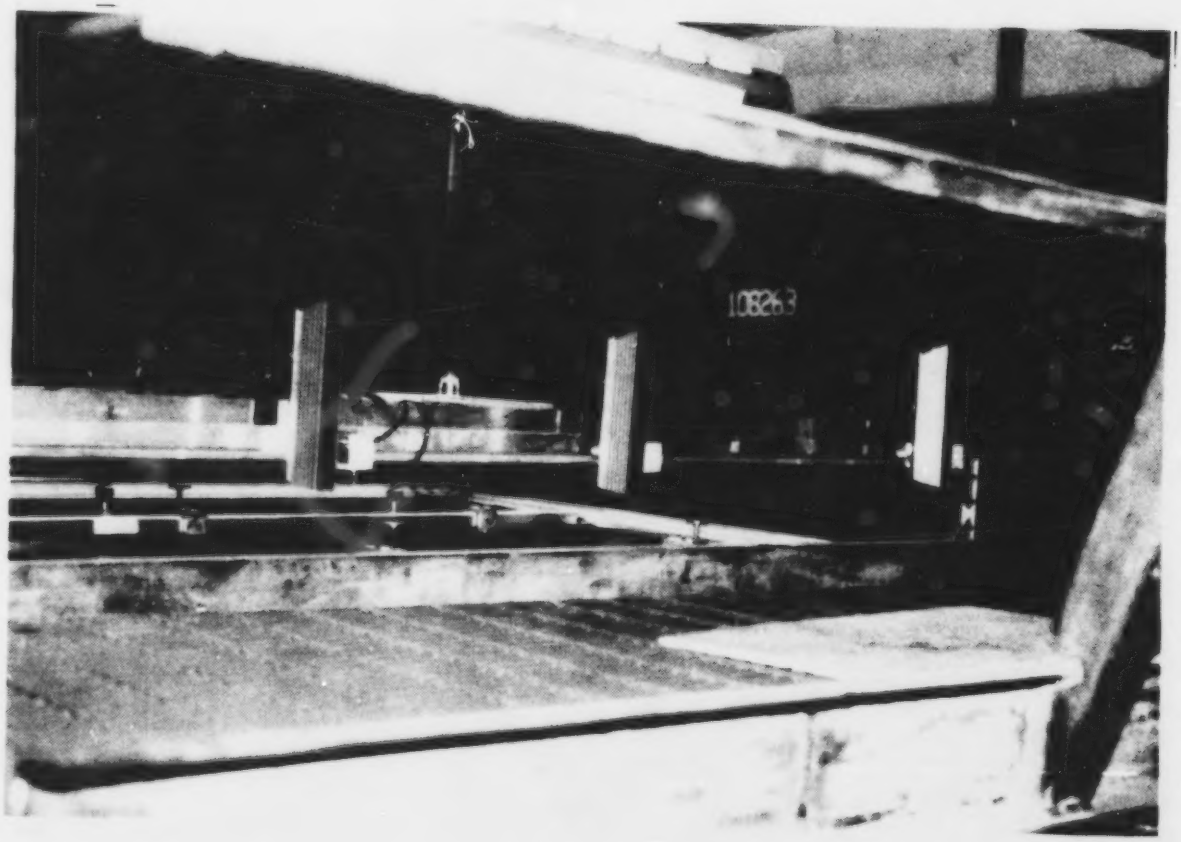

FIGURE 3 Temperature sensors

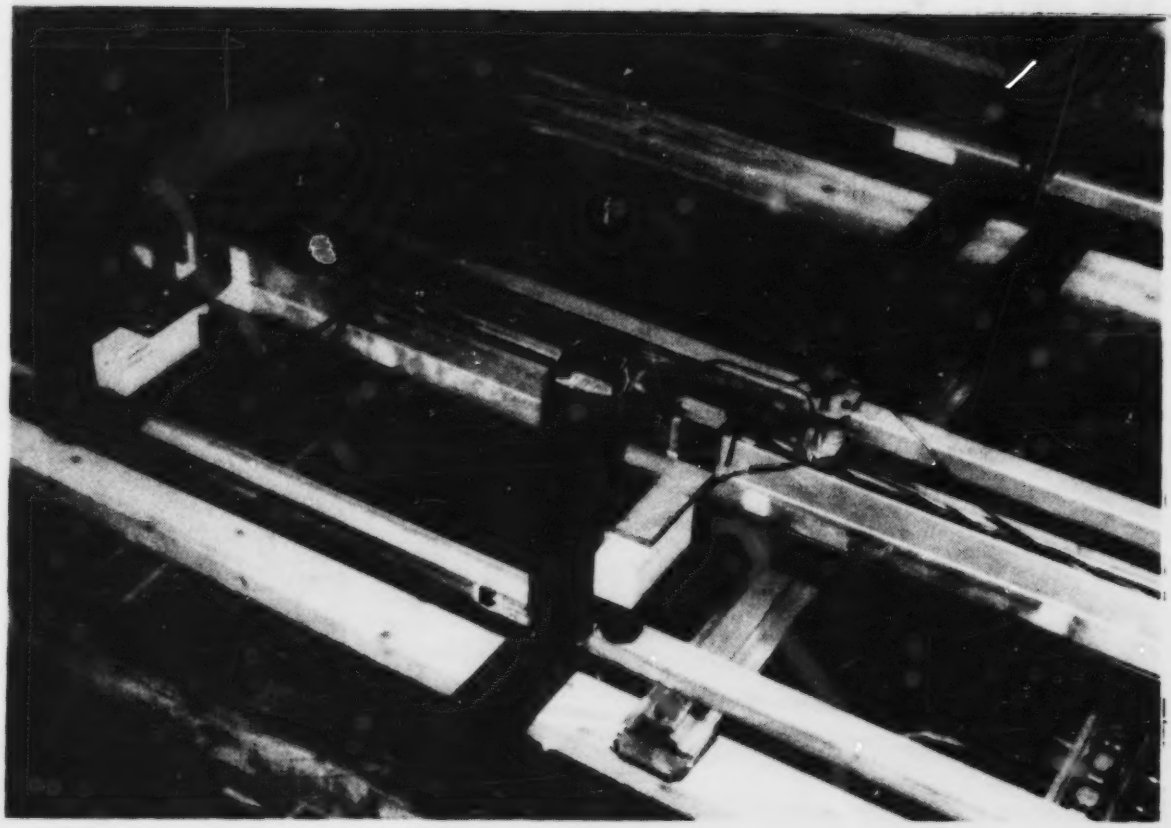

FIGURE 4 Close-up view of temperature sensors

FIGURE 5 Forintek computer system

FIGURE 6 Monitor display

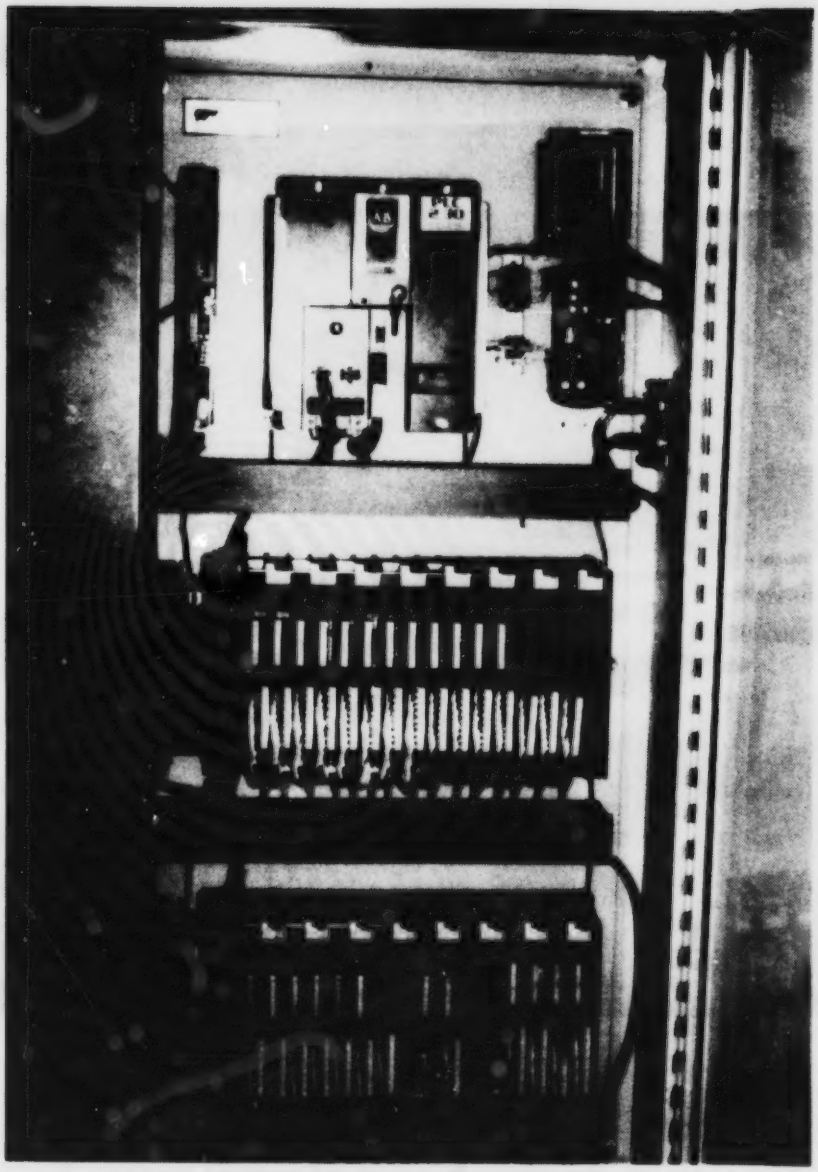

FIGURE 7 Programmable logic controller (PLC)

FIGURE 8 Size measuring system

FIGURE 9 PLC input panel

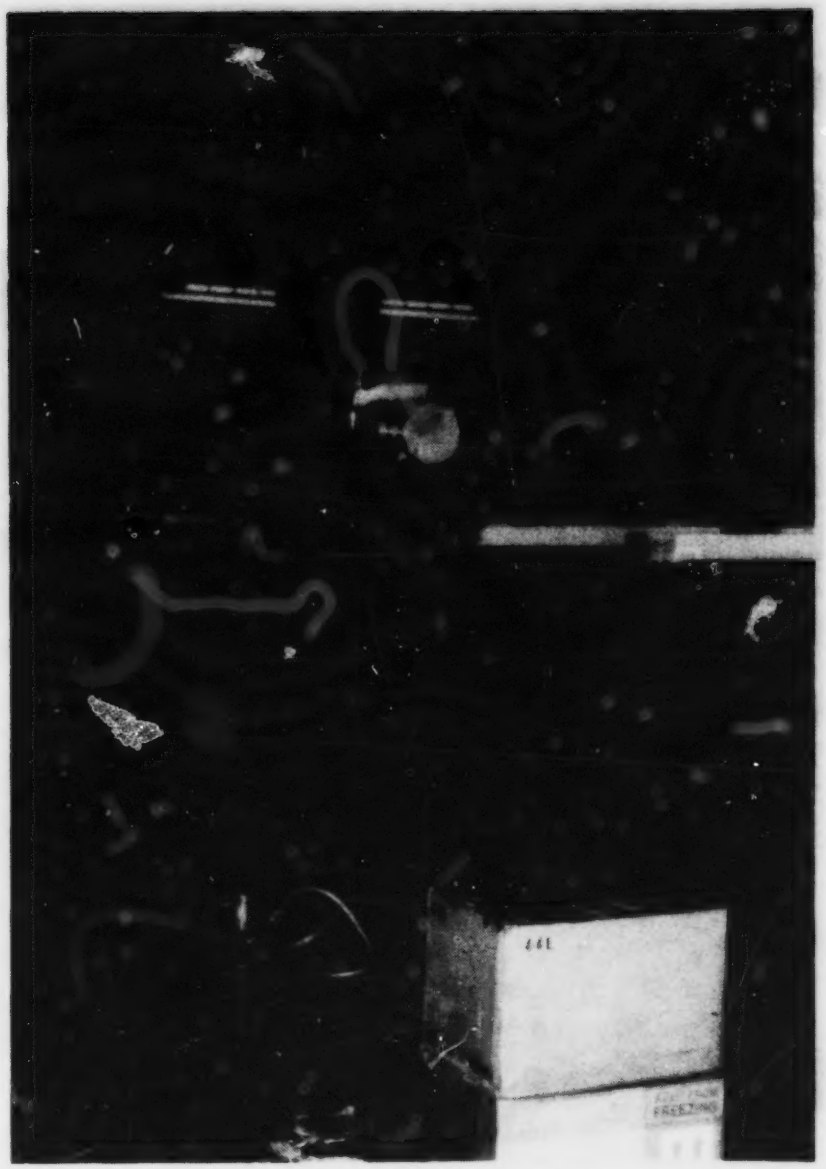

FIGURE 10 End spray system

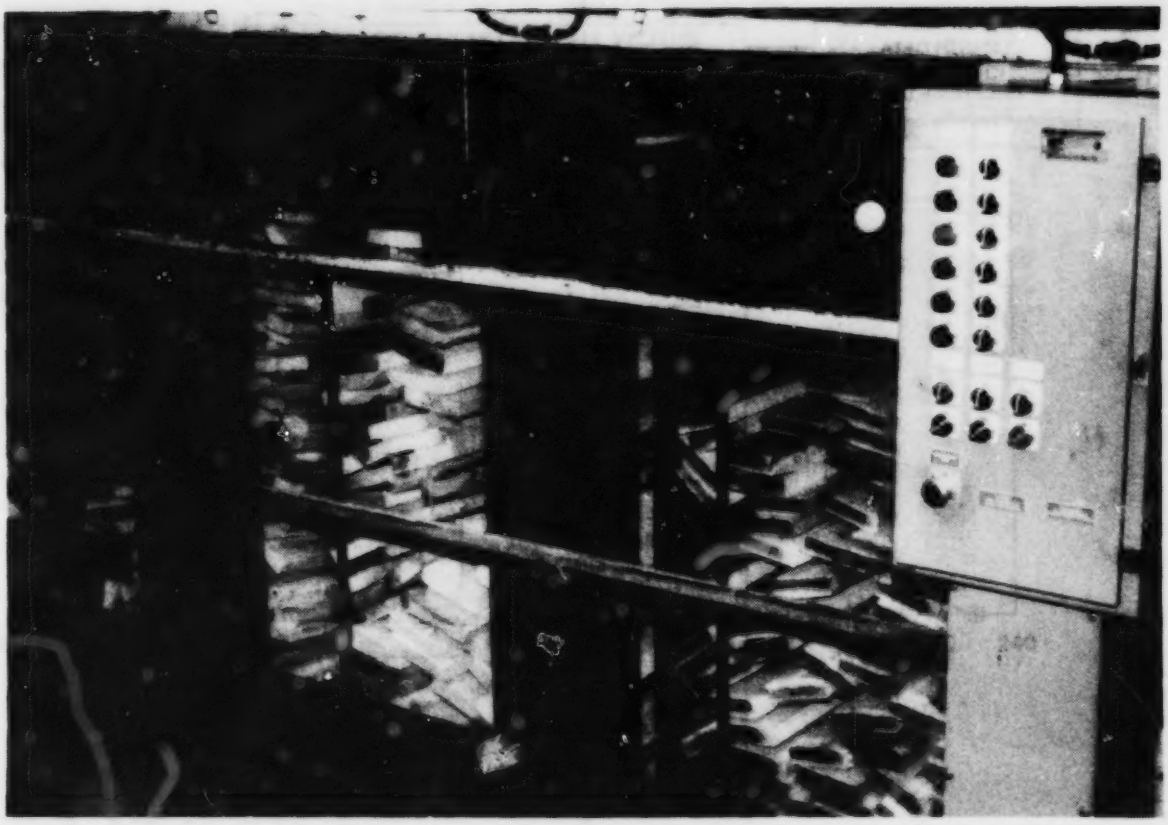

FIGURE 11 Sorted lumber

FLOW OF INFORMATION

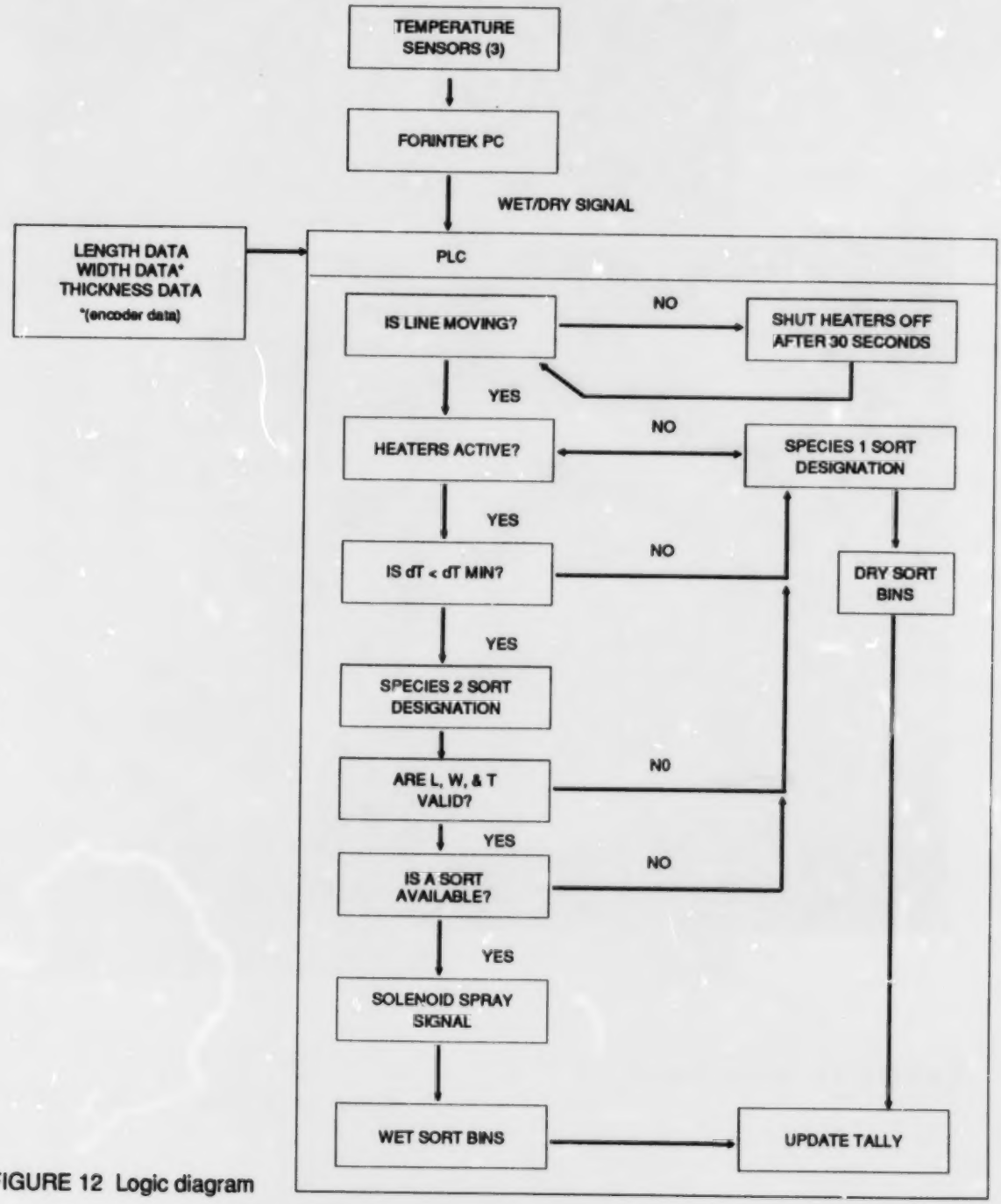

FIGURE 12 Logic diagram

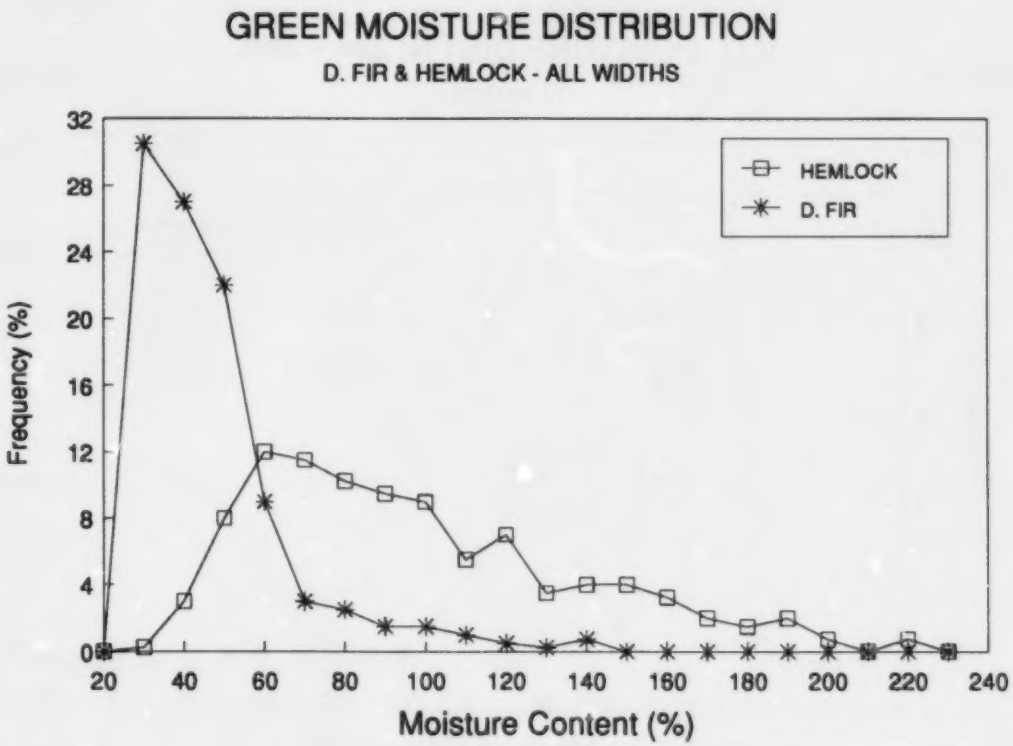

FIGURE 13 Green moisture distribution

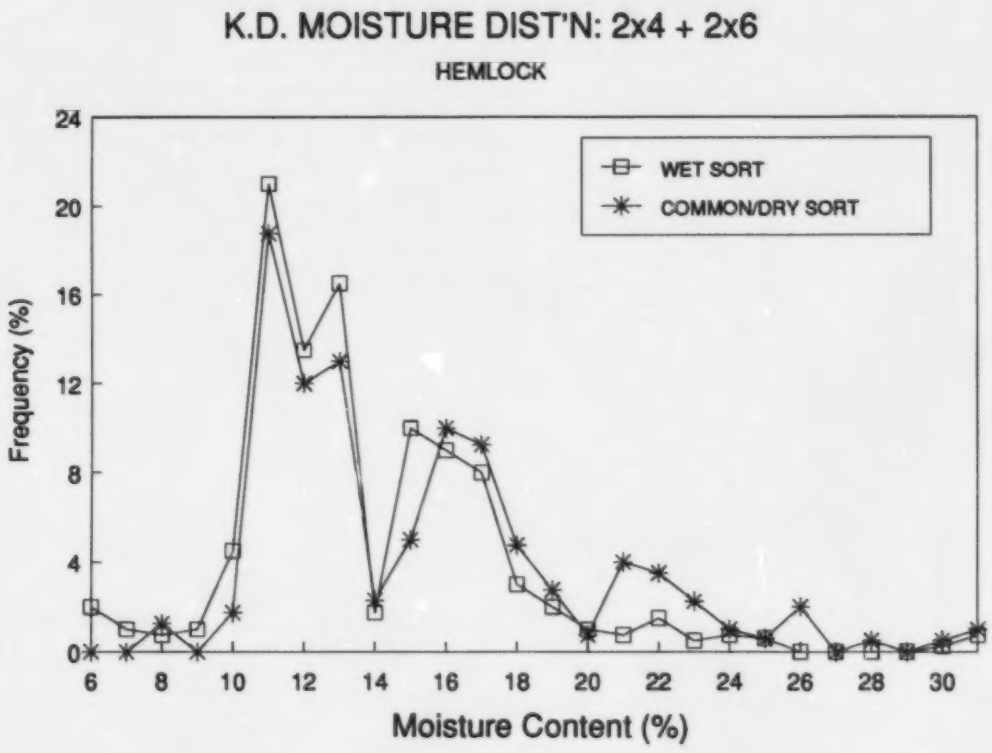

FIGURE 14 Moisture distribution for kiln-dried wet and dry sort hemlock

TABLE 1

SORTED AND UNSORTED KILN-DRIED LUMBER
MOISTURE CONTENT SUMMARY

SPECIES	SIZE	AVG. M.C. (%)	OVER 19% (%)
KFIR	2 x 4	13.6	1.0
	2 x 6	13.5	0.6
	COMBINED	13.5	0.8
HEMLOCK	2 X 4	15.2	12.6
	2 X 6	13.3	4.8
	COMBINED	14.5	9.6

TABLE 2

SORTED KILN-DRIED HEMLOCK
MOISTURE CONTENT SUMMARY

SORT TYPE	AVG. M.C. (%)	OVER 19% (%)	AVG. DYRING TIME (HRS)
WET	13.8	5.8	43.6
COMMON	15.4	17.1 (1)	44.3

CAMERA SCANNERS FOR COMPUTER OPTIMIZED BUCKING SYSTEMS

By

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CAMERA SCANNERS FOR COMPUTER OPTIMIZED BUCKING SYSTEMS

by

D.R. Giles

1. COMPUTER OPTIMIZED BUCKING SYSTEM

Computer Optimized Bucking (COB) systems have been used for many years to help sawmill operators improve profitability by bucking the stems into the best combination of sawlogs. Steve Wang and I commenced our studies of COB systems about three years ago by looking at the performance of longitudinal light curtain and transverse photo cell scanning systems. Recently I have been evaluating camera scanners systems which have been installed at three member mills.

First, let's review the recommendations, from our initial studies, to improve successful implementation of computer optimized bucking systems in your sawmills. These recommendations (Wang and Giles, 1987) are:

1.1 Debark log before bucking, unless scanner can accurately measure underbark log diameter

Scanning logs with bark intact means that the optimization process must include average bark thickness factors to calculate inside bark diameter measurements. Bark thickness varies with species, diameter, tree age, and distance up the stem from the butt. In addition, systems are not capable

of ignoring bark correction factors at points along the stem where the bark may have been removed during logging or transportation. These variables make it difficult to determine the underbark log diameters which, of course, are required for calculating the lumber recovery from each sawlog segment.

1.2 Diameter and sweep scanning be accurate to 0.4 centimetres or better

The importance of accuracy of diameter and sweep estimates varies with whether the scanning system has one- or two-axis scanning. Our recommendations were the accuracy level be near 0.4 cm for two-way scanning and 0.6 cm for one-way scanning.

1.3 Diameter and sweep be scanned in two perpendicular planes

Two perpendicular scans of the log are desirable, but most two-axis systems have scanning angles between 60 and 75 degrees, theoretically sufficient for accurate optimization.

1.4 Length be accurate to 2 centimetres

Length accuracy is also important since, if the system cannot determine the correct length of the long stem, the bucking solution cannot be optimal. Most systems are designed to have length accuracies within 2 cm, but our studies have shown that length estimates are not always that good.

1.5 Logs do not bounce, slide, roll or slip while being scanned

This point is particularly important in systems where the log travels through the scan zone. One system we studied showed that the log top diameter estimates were not even close to the field-measured diameters. I attributed the error to the fact that the stem top was not lying on the conveyor but was vibrating in the air as it was being scanned. The vibrating movement of the stem may be much faster than the calculated speed of the conveyor belt on which scanning accuracy has been determined. The important point is to try to reduce log movement during the scanning cycle and, of course, that is one advantage of camera scanning system design.

1.6 Nominal two-foot saw spacing be used for transverse bucking systems

Simulation studies of the transverse bucking system we studied showed that decreasing inter-saw spacing from four- to two-feet improved the value recovery of bucking solutions by one percent. If a full compliment of saws is not planned, a variable bumper to add flexibility to the butt log solution would be an alternative improvement.

1.7 Optimization program be able to achieve optimum solutions quickly

Any COB system you install should be able to calculate the optimum solution in time for the operator to view and complete the sawing solution without delay to the mill production flow.

1.8 Hardware be capable of operating in adverse mill conditions

Although the computer hardware may be built for 'industrial' installation, make sure the computer room is isolated from as much vibration and dust as possible. I have seen extremes in computer environments in the last year - very clean, self-contained, air-conditioned computer facilities and a setup where the computer was located in the operator's booth, right over the saw equipment with all the vibrations and dust associated with the operation. How the computer continued to function, in this latter design, was a mystery.

1.9 Self-diagnostic capability be built-in for the computer and scanning systems

Systems come equipped with a variety of reporting and diagnostic features. The ability to quickly determine the operating status, and detect system failures and other problems before too much time and profit are lost to non-optimal bucking decisions would be an important advantage.

1.10 Lumber output for log segments be determined accurately and classified by diameter, sweep, taper and length

Make sure that the algorithms accurately simulate the log breakdown process and recovery obtained in the mill. Small recovery tests can help determine the accuracy of the optimization program in the COB system.

1.11 Butt ends be manually squared before scanning or be optimally squared by the scanning system

Improper bucking in the woods should be corrected so that the butt log length is sufficient for full length lumber recovery. Some systems incorporate the use of a mechanical bumper which will allow adjustment to the location of the stem end relative to the sawlines, thereby correcting poor bucking practices in the woods. Another advantage of a bumper is that the scanning system location of the log end is known which should improve the accuracy of length estimates.

1.12 Lumber prices and operating costs be specified accurately

Operating costs and lumber prices are used to determine the value of each possible log segment. Shorter logs will result in increased downstream costs because of the increase in piece counts. Often the price table is manipulated to control the length distribution of sawlogs, but this can lead to unrealistic lumber prices over time, which will produce sub-optimal bucking solutions.

1.13 Log trim allowance be reduced to near the minimum required

Many sawmills use a 4-inch trim allowance at the bucking station. We

measured the actual bucking accuracy at one mill and found a consistent 4-inch trim. We recommended that they reduce their trim to 2.5 to 3 inches. Improvement in lumber recovery from this change would come from additional two-foot increments for some bucking solutions and larger top diameters for the sawlogs which would result in the selection of a larger set pattern for some logs.

Those were the recommendations and requirements we identified for achieving maximum performance from COB log bucking in our previous study. I will show you that they still apply for camera scanning technology for computer optimized bucking.

2. CAMERA SCANNING TECHNOLOGY DESCRIPTION

Camera scanning technology, based on video edge detection, has been developed by Applied Scanning Technology of California (AST 1987). There are three systems installed at Forintek member mills in British Columbia and Alberta. Overhead cameras scan about eight feet along the length of the log, so the required number of cameras can be determined by the overall length of your logs.

The cameras should be mounted on a sturdy framework to minimize the vibrations from the mill operations. The other critical feature of this technology is the lighting. Rows of spot lights are directed towards the edge of the log so the overhead cameras can detect the difference between

the log and the log deck background. The lighting angles are very critical for the cameras to operate efficiently.

The system has built-in self calibration capability which is one of the recommendations from our initial study. It also has computer diagnostic routines that can assist mill management determine how the system is functioning and allow corrections or adjustments if something is wrong.

System interface with the operator controls can range from simple display of the bucking solution at the operator's control panel to automatic interface with saw positioners, log stops and other controlling devices. A system installed at one sawmill includes complete control of all the bucking hardware except the actual dropping of the two bucking saws (although the system was not yet completely debugged). This system was designed to drop the appropriate log stop to buck the butt log, and position a second travelling cross cut saw at the appropriate distance from the stationary bucking saw. The operator could then activate the drop saws to buck two sawlog lengths at once.

3. SYSTEM OPERATION

Each camera takes a snap shot of the entire field of view and determines the location of the log edges approximately every two inches along the length. The lighting allows the edge of the log to be detected. The scan data is computer analyzed to determine which data points are log and which

are background. The mapping takes about 1.25 seconds for a 60-foot stem, which is very fast.

Using the 'raw' log data, a log modelling process calculates stem parameters by quadratic equations that describe the log as a truncated curve form. These equations are then used to calculate the 'fit' of the log by diameter and shape along its entire length.

Bucking solutions are calculated by use of algorithms and customer entered parameters such as saw kerfs, cutting patterns, product prices and operating costs. The optimization program is customized to simulate individual mills. All bucking combinations are evaluated and the solution generating the highest revenue (or highest recovery) is chosen. The optimum solution is displayed to the operator who can then choose that solution or, alternately, a manual solution if desired.

There are a variety of reports that this system can produce, ranging from 'raw' scan data, log data after the 'fit', a 25 log summary and production summary reports.

4. MILL TEST PROCEDURE

The field procedure to evaluate or test the efficiency of a bucking system involves careful measurement of a sample of long logs, processing them through the bucking system, collecting the bucking data, and then

determining downstream the lumber recovery factor. Alternatively to collecting LRF data, sawing can be simulated using SAWSIM, or some other computer program.

Mill personnel are responsible for setting out the sample of stems. We examine each log, marking points where the shape or diameter changes abruptly, or at least every four feet along the stem. Starting at the large end of the log, the horizontal and vertical sweep is measured with the aid of a laser transit and diameters in both planes are estimated using calipers. This information is collected in a form compatible to that required for the SAWSIM simulation program. Figure 1 shows a sample of the field data collected for each stem.

5. PRELIMINARY RESULTS OF FIELD STUDY

I will show graphs of a few sample stems which compare field collected data with that produced by the camera scanning system for the log shape, diameter and length. The vertical scale of these graphs, which represents stem diameter, is quite exaggerated giving the logs a short, fat appearance. I plotted the scan data for the same points along the stem at which we measured the sweep and diameters.

The first stem (Figure 2) is about 57 feet long. The top graph (a) is what we measured in the field - this is the sweep and diameter as measured in the horizontal plane. The bottom graph (b) is the camera scan data (after

smoothing). I plotted only the points along the stem where we measured the log in the field, but computer information was actually calculated every two inches along the stem.

We took two scans of every log - one under normal operating conditions where the hour glass rollers were moving under the log as it was scanned, and the second when all equipment was stopped. This second scan was activated by the operator. The moving and stopped length estimates for the log were both 53 feet, while the actual length was 56.8 feet. The length estimates were not very accurate but you can see that the scan information for diameter and shape fits quite well.

The bucking solution (Figure 2b) for this log was two 18-foot and a 16 residual (in reality the residual would be 20 feet). Both moving and stopped scans produced the same bucking solution. It may appear obvious from the graph that the first buck should be at 16 feet to incorporate the change in sweep direction. The analysis is incomplete, but a possible explanation may be that curve sawing technology at this mill (which Steve Wang and John Hards will be discussing later) may be capable of handling this amount of sweep - its about 2.2 inches in 18 feet.

Figure 3 shows the field measured data (horizontal view) on top (a), matched with the scan data (b) on the bottom for a second log. The computer fitted data smooths the raw (scanned) data so that all the small jogs and deviations are not reproduced. The length estimates for the moving and stopped scans were 53.3 and 49.3 feet, respectively, compared

with actual length of 50.8 feet - a slight improvement in length accuracy with the stopped scan. The bucking solution also changed (Figure 3b). The optimization process initially identifies severe crook and sweep and bucks those sections - in this case the 8-foot third log. The moving scan bucking solution was 20, 8, 8 and a 16 residual (which would be a 12 in reality). The stopped scan recalculated the solution as 16, 12, 8 and 12. The main difference was therefore in the location of the butt log cut.

Laboratory analysis will determine if there are significant differences in the bucking solutions between the moving and stopped scans as well as the theoretical solutions based on field measured data. We will continue to work with Applied Scanning Technology, the system supplier, to suggest improvements which could be made to the camera scanning technology.

6. SUMMARY

Our studies have indicated that there are several points to consider if you are planning to implement computer optimized bucking with camera scanning, and these continue to be applicable to camera scanning systems.

6.1 Debark before scanning

Lighting of the log is critical for a good scan and experience at these installations shows that color changes caused by surface moisture, missing bark, and tree species increase the difficulty of detecting the edge of

the log.

6.2 Stop the log for scanning

All our field studies show an improvement in length measurement when the logs were stopped for scanning. Analysis of the change in bucking solution will determine if improvements result in significant bucking changes.

6.3 Reduce handling impact of stems before and after scanning

Deck design can decrease log breakage and help improve scanning accuracy by reducing log movement during the scan cycle. Dropping of logs onto conveyors should be avoided. One system design incorporated lift bars which were employed to lower the log gently from the log singulator into the scan zone. This greatly reduced log vibration and log breakage.

6.4 Even-end stem to specified point before scanning

Even-ending the stem before scanning should improve length accuracy by positively identifying the location of one end of the log.

6.5 Involve operational staff for system acceptance

Employee attitude to technological change is very important to the success of installations and reduction of training and debugging phases of implementation. Technology which is viewed suspiciously by incumbent

operators is almost bound for failure or at least costly implementation.

6.6 Lumber prices should compromise between product prices and demand

Bucking software packages usually allow mill management to adjust lumber prices and other variables on which the solutions are based. It becomes very easy to manipulate the product mix to desired lengths (and lumber sizes) by changing individual lumber prices. It is important that these values be checked periodically to ensure their magnitudes have not been skewed in favour of particular lengths or widths. Make sure the price and demand tables are realistic.

6.7 Improved equations to define the end segments of stem profiles

Investigate the type of algorithms used in the optimization process to ensure that the best bucking solutions are obtained. Applied Scanning Technology is planning to improve the equations for fitting the raw data to shape the log by incorporating different quadratic equations for the butt and top sections of the stem. Algorithms are usually proprietary so sawmill testing is recommended to evaluate the efficiency of the software to simulate sawmill performance.

7. REFERENCES

AST - Applied Scanning Technology 1987. VED-300-1 Snapshot Log Scanning System with Snapshot Optimization Software for Log Bucking Applications. AST Technical Report. Mountain View, California, March 1987. 21pp.

Wang S.J. and D.R. Giles 1988. Achieving Maximum Performance From Computer Optimized Log Bucking. Forintek Technical Report. Vancouver, January 1988. 30pp.

SAWSIM STEM DATA FORM

Date: MAY 3/89 Stem Number: 3

SPRUCE

Length from Zero End		Diameter Inch		Sweep Inch		Presence of Bark Yes=(1), No=(0)			
Foot	Inch	V	H	V	H	R	L	B	T
0	0	15.0	14.9	7.10	10.60	1	1	0	1
1	0	13.5	12.8	8.15	11.50	1	1	1	1
3	1	12.1	11.8	8.65	10.85	1	1	1	1
7	0	11.0	10.9	8.40	9.85	1	1	1	1
10	0	10.3	9.9	9.15	9.00	0	1	1	1
14	0	9.9	9.7	9.15	7.20	1	1	1	1
18	0	9.5	9.0	9.05	6.30	1	1	1	1
22	0	8.8	8.4	9.25	5.00	1	0	1	1
25	6	8.1	7.8	8.70	4.95	1	1	1	1
30	0	7.7	7.5	8.05	4.15	1	1	1	1
32	0	7.4	7.2	8.00	3.55	1	1	1	1
34	0	7.0	6.7	7.76	3.60	1	1	1	1
35	11	6.6	6.3	7.60	3.65	1	1	1	1
40	0	6.2	6.0	6.65	3.60	1	1	1	1
44	0	5.3	5.4	6.20	4.20	1	1	1	1
48	0	4.9	4.6	6.10	5.10	1	1	1	1
52	0	4.3	4.2	5.85	5.65	1	0	1	1

Zero end will be near the fence stop of the bucking station.
Log surfaces defined as right (R), left (L), bottom (B), and top (T) as viewed from the zero end of the log.

FIGURE 1 Field data sheet for diameter and sweep measurements

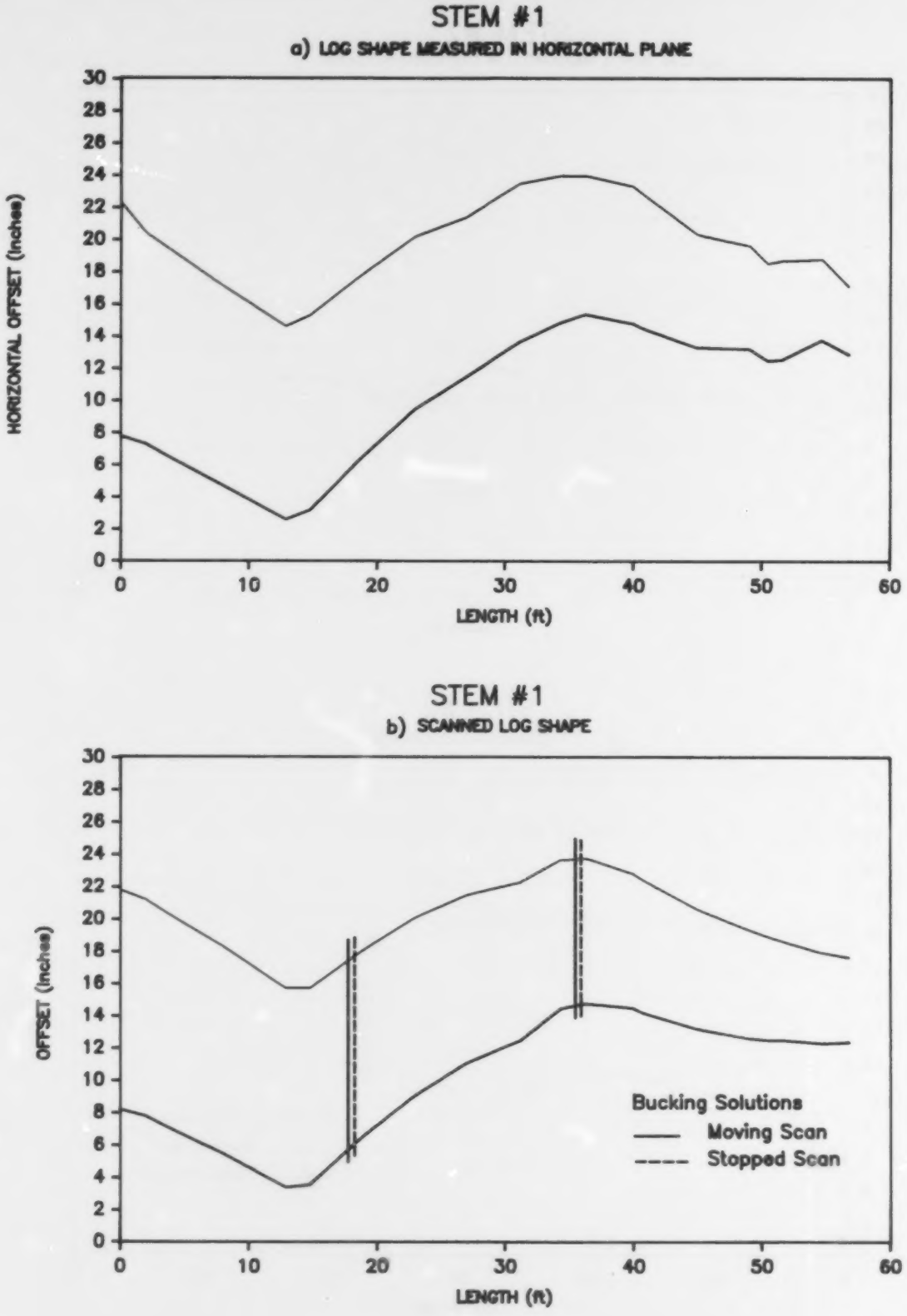

FIGURE 2 Comparison of measured and scanned diameter and sweep data (stem 1)

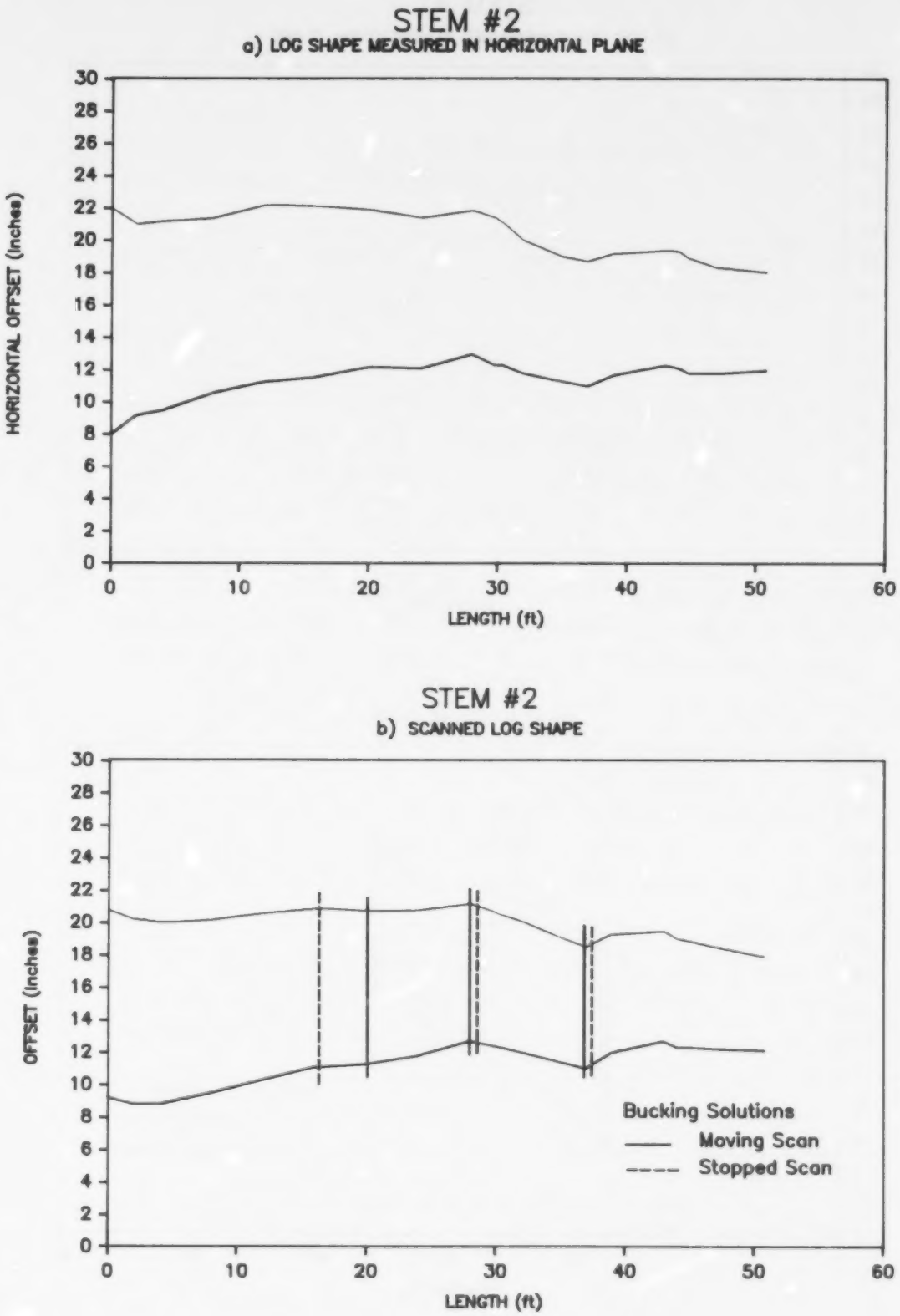

FIGURE 3 Comparison of measured and scanned diameter and sweep data (stem #2)

LUMBER INCISING

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V6T IX2

LUMBER INCISING

by

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There is an increasing demand for treated wood in the United States and this represents a significant opportunity for Canadian lumber producers. Unfortunately, our Canadian wood species, particularily spruce-pine-fir (SPF), do not treat easily due to low permeability. This places them at a disadvantage to Southern pine which currently supplies the market. Southern pine is a very permeable species that drys more quickly than our SPF and is easy to treat.

The question is what can we do to our wood to increase its permeability? One simple answer is incising. Not incising as used in the past, but an incising process that is fast, at least 1000 ft/min., which would allow it to be used in-line at a sawmill rather than at a treatment plant; and incising that does not degrade the wood surface, but produces a dense pattern of incisions that are barely visible yet penetrate at least 10 mm. or more into the board.

Forintek has developed a prototype lumber incising machine, that we feel meets these specifications. The design of the machine's incising head comes from Forintek's research on veneer incising and has been patented by Forintek. The incising head is a single steel roll with wedge-shaped teeth machined right in which makes it more durable than

heads with conventional inserted teeth. The head is nickel plated and this, along with the shape of the teeth and the high feedspeed, reduces stripping of the lumber. The head produces denser incision patterns than those made by conventional incisors.

The machine is built to incise green 2" x 4" lumber to a depth of 10-12 mm. along the grain. Since it does not cut the wood fibers, strength loss should be negligible. Tests are being conducted with two incising roll designs. The first provides a density pattern of 9-10,000 incisions/m.

The machine at present, has a single incising roll, however once the optimum roll design is established it will be modified to four rolls, allowing the boards to be incised on all sides in one pass. The machine is easy to transport and once its design is complete it will be made available to members for on-site testing.

Preliminary drying tests with the lower density incising roll indicate a reduction in lumber drying time and a significant improvement in preservative uptake. Tests with the higher density roll are presently underway and the results should be out shortly.

INCISING FOR DRYING

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INCISING FOR DRYING

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The objective of using incising as a pretreatment to drying is simply to open up more pathways for water to flow through the wood. By incising, water has less distance to move until it reaches an open space where it can be evaporated. In practical terms what we are really trying to do is to change the drying properties of our species, SPF in particular, closer to those of some competing species such as U.S. Southern Yellow Pine and Australian radiata pine. Wood of these species is extremely permeable and can be dried very rapidly, without degrade at temperatures in excess of 240°F. Drying SPF in these conditions usually produces high levels of degrade that offset any economic benefits resulting from reduced drying times. If we can improve the permeability of SPF, fast drying can likely be achieved with acceptably low levels of degrade.

A number of approaches to increasing permeability for drying have been investigated previously but none has achieved commercial acceptability. Examples include, drilling holes parallel to wide faces in aspen studs, and incising with nails, needles and lasers in a variety of softwood and hardwood species. One of the most serious drawbacks to some of these methods and to incising as is carried out prior to preservative treatment, is that of poor surface appearance that may not be acceptable in the marketplace.

The Forintek incisor has the advantage of producing a very large number of 'holes', but in such a way that appearance is not sacrificed. The tests described below compare drying of matched kiln runs of SPF 2x4x3 ft. lumber where half of the material was incised on four sides with the Forintek high density incisor, while the remainder was unincised controls.

The first shipment of SPF was first sorted according to green moisture content (MC). The high MC group averaged about 87% MC and the low MC group averaged about 44% MC. Following incising of half of the pieces in each MC group, drying was conducted in a small laboratory kiln using conditions of 240°F dry bulb temperature, 160°F wet bulb temperature and an air velocity of 600 ft. per min. through the load. As shown in Figure 1, in both MC groups the incised lumber dried faster than the unincised controls. To a target dry MC of 16%, the reduction in drying time for the high MC group was 20% and for the low MC group was 23%.

The second shipment of SPF that was tested was considerably drier than the first. The procedures used in preparing test loads were as described above. The high MC group averaged about 46% MC while the low MC group averaged about 27% MC. Kiln conditions used were dry bulb temperature 300°F and wet bulb temperature 160°F with an air velocity of 600 ft. per min. through the load. Again, as shown in Figure 2, the incised lumber dried faster than the unincised. To a target MC of 16%, the reduction in drying due to incising was 19% for the high MC group and 52% for the low MC group.

Although degrade could not be adequately evaluated in lumber samples of the length used, surface appearance of incised pieces was excellent with no evidence of fiber pull-out or extension of the incisions into surface checks. Upon completion of a 10-inch wide incising head we will be evaluating the impact of incising on 2x10x8 ft. lumber in terms of both drying rates and dried lumber quality.

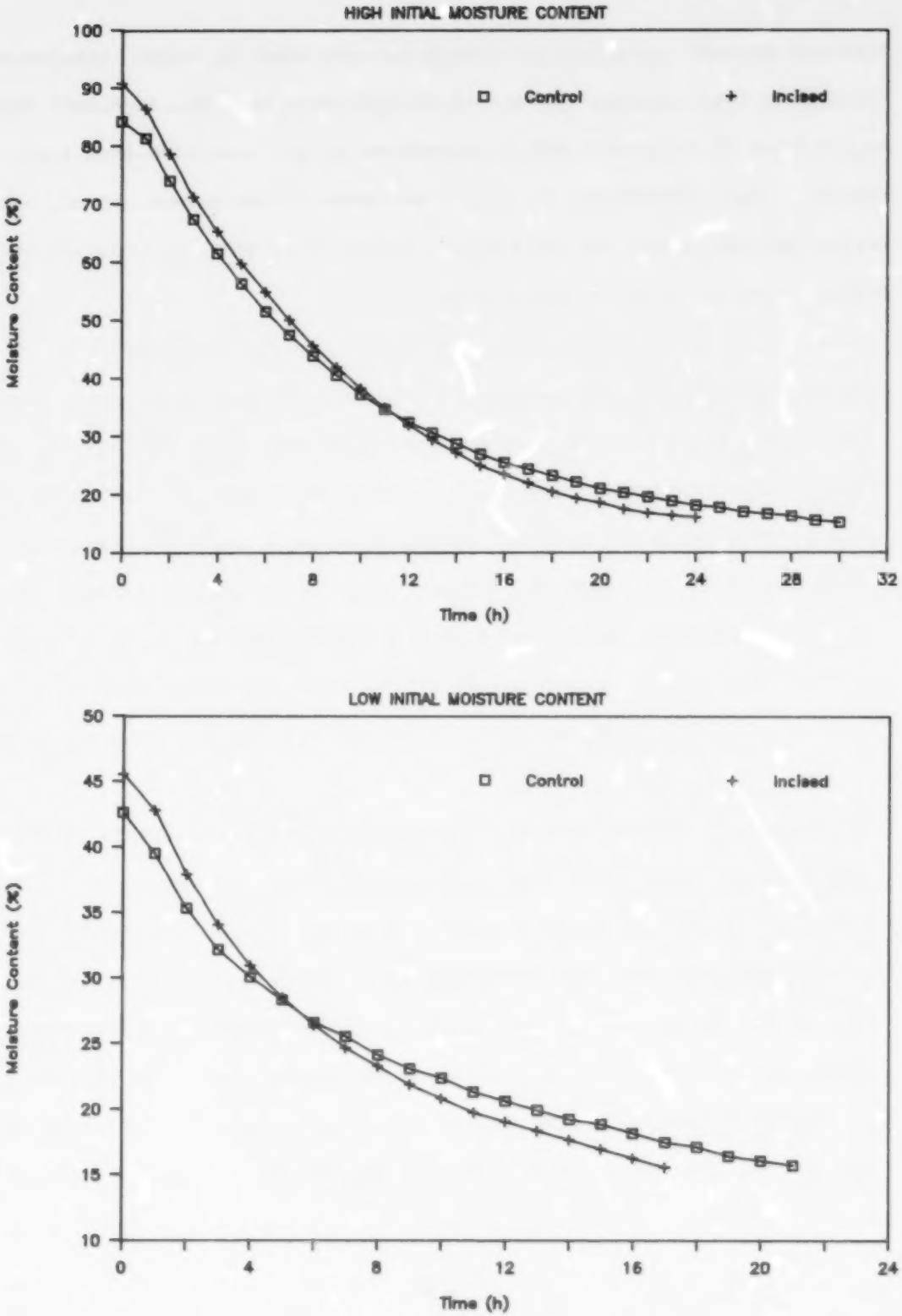

FIGURE 1 Drying rate curves for incised and control SPF 2 x 4 lumber (shipment 1)

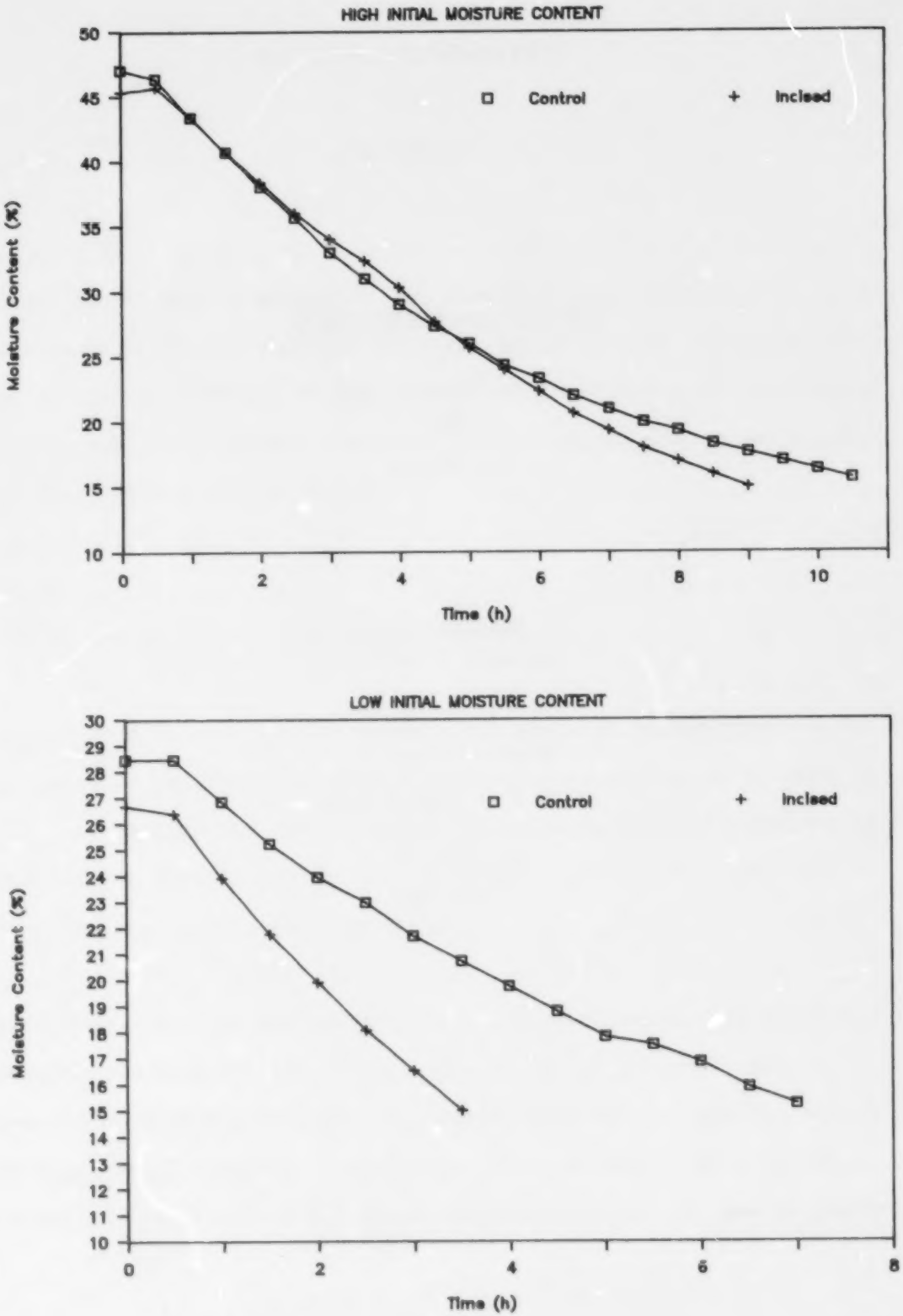

FIGURE 2 Drying rate curves for incised and control SPF 2 x 4 lumber (Shipment 2)

INCISING/PRESERVATION

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INCISING/PRESERVATION

by

Paul Morris

I will begin this presentation by providing some background to the development of the two Forintek incisors, follow that by discussing some data on the treatability of SPF incised with our prototype high speed incisor, and then consider optimized processing and the potential for marketing a treated SPF product.

1. BACKGROUND

Incising wood to improve its permeability has been common practice for many years in the pressure treatment industry. The purpose of incising is to open a rapid pathway for a treatment solution to enter the wood and to allow it to spread out within the wood providing a solid zone of protection around the outside of the piece.

The original incisors had blunt teeth, that were spaced wide and had a detrimental effect on the surface appearance of the wood (Figure 1). These blunt tooth incisions were, however, spaced closely enough to produce a solid zone of treated wood in relatively permeable western hemlock (Figure 2). This was not always the case with our less permeable

species such as spruce. The lower piece of lumber in Figure 2 is a piece of treated lodgepole pine and, in contrast to the hemlock, the areas treated from each incision are not meeting up. The degree of treatment is quite variable over the whole surface. Taking a boring from this piece we might measure 10mm penetration if we hit close to an incision, but if we take a boring between incisions the piece would fail to meet the Canadian Standard which requires 10mm penetration in 80% of pieces sampled.

The problem then, in some of our less permeable species is the difficulty in joining the gaps in treatment that occur between the incisions. The incision spacing necessary to do this can be determined by measuring the area treated from one incision.

Using a single point incision or a needle, we find that typical treatment penetration in spruce and lodgepole pine is about 2mm laterally, either side of the incision and about 20mm longitudinal (Figure 3). Trying to put incisions this close together with the old fashion blunt type of incisor is likely to cause serious damage to the surface of the wood and a totally unacceptable appearance. The treated wood industry in general has therefore been moving towards sharper teeth, to give a better surface appearance. However, even sharp teeth when placed much closer together can pinch the wood and strip the surface off lumber. To combat this problem, the industry has developed cleaning rings (Figure 4). These are spacers which are placed in between the incisor rings and act to push off strips of wood that would otherwise clog up the teeth. The need to have

these spacer rings limits how close together we can put the tooth rings.

2. DOUBLE DENSITY INCISING

Forintek has developed a double head incisor system for commercial incisors to solve the spacing problem. This applies a second set of incisions immediately between the first set and gives us the very close spacing (12,000 incisions per square meter) that we need for spruce, pine and alpine fir (SPF). One obvious concern with using double the usual number of incisions is the potential for strength loss. Because of this concern we have done tests to compare incising lumber in the dry condition to incising it in the green condition. Figure 5 shows that when incising dry we get a punching effect, and we still see some surface damage even with thin sharp teeth. However, incising it in the green condition we get a slicing effect, and barely visible incisions. The treatment quality is equally good with green as with dry incising despite the reduced fibre damage. Furthermore we have demonstrated on small test beams that incising the lumber green gives us a negligible strength loss (around 5%). We now have an experiment underway in which we will be incising full length pieces, and a much larger number of them, to give us a reliable figure for the strength loss caused by thin teeth with this very high density of incisions.

If we move toward incising green lumber, than it should be done in the sawmill to avoid having to ship green lumber to a treater. By incising prior to drying, we might expect some improvements in the drying time, as

described by Graham Mackay, and possibly incur less degrade. This improvement will help the incisor to pay for itself, increasing the margin expected from selling incised lumber as an added value product.

Two problems may arise with the double density incising machine which will be commercially available. One problem is feedspeed. The moving rings may generate a lot of friction if the machine is run at mill speeds. Commercial machines currently run at 350 or 450 feet a minute. We could probably push them up to around 600 feet a minute but in a mill you want to go for 1000 or 1400 feet a minute, and this machine may not be suitable for that production rate. The second problem is the stripping. Although these cleaning rings cope with it by pushing the strips off, that sort of damage to a significant percentage of lumber would be unacceptable to a sawmill.

3. HIGH SPEED INCISING

The need to run at higher speeds and to eliminate stripping lead to Don Walser's new incising head design. This design has reduced stripping to a negligible amount, it runs at 1000 feet a minute, leaves an excellent surface appearance (Figure 6), and it still allows us to get 12,000 incisions per square meter into each board.

This high speed incisor has been developed over the last few months, the drying work has been done over the last few weeks, and the treating work has been done over the last few days. Figure 7 shows cross sections of

SPF pressure treated with chromated copper arsenate (CCA). In the unincised boards, we have penetrations of around 1 or 2 mm. There are also odd areas of penetration in the pine typical of red heart. Similarly, there is some heartwood penetration of parts of the alpine fir, again maybe associated with some early decay. In general there is very poor penetration over most of the surface. When we apply the high density of incisions we see deep penetration that is more uniform around the piece with just a few gaps. However, this was high temperature dried material and we normally expect this process to have some adverse effects on treatability. Figure 8 shows SPF which was not kiln dried prior to treatment and here we see an even better treatment. The gaps are closed up and we have achieved an intact zone of treatment 8 mm deep all the way around the lumber. Consequently, if we were selling a specialized SPF product for treating we would want to dry it to a higher target moisture content, again achieving some savings in drying time.

4. RESULTS

Table 1 shows results of the penetration and the retention tests both in terms of the percent of samples which, when bored, showed over 10 mm penetration, and in terms of the amount of chemical retained in kilograms per cubic meter. The standard requirement is to get 80% of the samples to show over 10 mm penetration and a retention of 6.4 kilograms per cubic meter. Presently, our dry-sort results fell quite short of that, but we have a better performance in the wet-sort. We also have a much better

surface appearance in the wet-sort because the sharp teeth slice between the fibers of the wetter lumber and do not cut them. So moisture sorting proves useful in this context. The wet-sort had about 55% of samples over 10 mm and a further 35% of the samples had penetrations of 8 or 9 mm. We were also very close to the amount of chemical specified in the Canadian standard.

At the moment there are a number of standards in use. The American standard, the Canadian standard and a Canadian Industry standard which has just been introduced and has a 5 mm penetration requirement for above ground residential construction. With this prototype high speed incisor we are practically meeting all three standards on retention. We are meeting the Canadian Industry standard on penetration, but not quite meeting the Canadian and American Standards. However, with a slightly deeper incision we should be able to meet all three standards.

5. THE POSITION OF INCISING IN THE SAWMILLING PROCESS

Now I would like to consider where we might place the incisor in the sawmill process. Currently the mill is sawing, drying, planing and shipping the lumber. The treater is then receiving it, incising it, and treating it. However, he is receiving a product the mill has dried below the optimum for treating, and he is also incising the lumber dry and getting a poor surface appearance.

We might therefore look at some alternative processes. Firstly, moisture sorting to improve our drying, and also to give us a better surface appearance when we incise. We might consider deep incising, partial kiln drying,(getting some savings in the drying time,) planing off part of that incision then shipping the treater a treatable product. However, we do tend to loose a great depth of incision when we plane after incising and that may not be practical. Perhaps a better alternative for a specialized treatable product for the US market would include planing green, prior to incising, and then partial kiln drying prior to shipping. Obviously this is going to cause some problems in lumber sizing which would have to be resolved.

Perhaps the optimum process would include treating the product prior to shipping. Why send the lumber to a U.S. treater when we could maximize our added value on this side of the border and then ship it into the States or into other markets? That thought leads into the question of marketing a treated SPF product.

6. MARKETING TREATED SPF

We are looking not only at the potential for an added value product, but also at sending that product into a market which is much less dependent on housing starts. At the moment, 49% of the U.S. consumption of treated lumber is going into residential, remodelling and repair, not original construction. Furthermore, over the last 10 years the amount of treated

lumber used in the U.S. and Canada has been increasing at a rate of about 10-15% a year. It is not expected to continue at this rate, but may level off or slightly increase from the current level of around 6 to 7 billion board feet. Currently 85% of the treated lumber consumed in the U.S. is Southern Yellow Pine from the southern States. Table 2 shows production and consumption of treated lumber within the U.S. by region. The US south has a major surplus of treated lumber and that gets shipped north to the North Central, the North East and the Western regions. About 1.6 billion board feet of treated lumber is moving around the US per year. Canada should be able to get at least a portion of that market by shipping SPF down from the North.

SPF would already be preferred for residential, remodelling and repair because of its workability and its stability. However it has been kept out of that market for two reasons: its poor treatability and the fact that it is not in the US wood preservation standard. Its not in the US standard because up to now it has not been effectively treatable. If we can demonstrate the treatability of this material and if we can get it into the standard, it should be price competitive with Southern Yellow Pine.

Since 1978 the price ratio of SPF to Southern Pine has moved from close to 1 to 1, to a current level of about 0.8 to 1. We believe that a treated SPF product could probably undercut treated Southern Yellow Pine by a substantial margin, and there is no reason why that price differential should not continue. Currently Southern Yellow Pine

production is pegged at around 12 billion board feet a year and almost 50% of that is going into the treated wood market. It is a question of supply and demand. The price of Southern Yellow Pine is not likely to come down, but we may be able to bring the value of SPF up to its level.

7. SUMMARY

In summary, with a little further work we expect to be able to meet the Canadian and US treated wood standards with incised SPF. The product has a good surface appearance, the incisor can run at mill speeds, and there is a potential market for that lumber in the US.

TABLE 1

CCA TREATMENT OF GREEN PLANED GREEN INCISED SPF

	PENETRATION % over 10mm	RETENTION Kg/m^3
Dry Sort (under 33% moisture content)	25	5.5
Wet Sort (over 33% moisture content)	55	6.3
Standard Specification	80	6.4

TABLE 2

TREATED LUMBER PRODUCTION
CONSUMPTION AND SELF SUFFICIENCY IN THE U.S.
BY REGIONAL SHARES (%)

REGION	PRODUCTION	CONSUMPTION	SURPLUS/ - DEFICIT
N. Central	9.9	28.5	-18.6 (= 800 MMfbm)
N. East	6.1	21.1	-15.0 (= 700 MMfbm)
South	74.0	37.9	+36.1 (= 1700 MMfbm)
West	10.4	12.5	- 2.1 (= 100 MMfbm)
	100%	100%	

Sources: Walsh, 1985; RISI, 1988

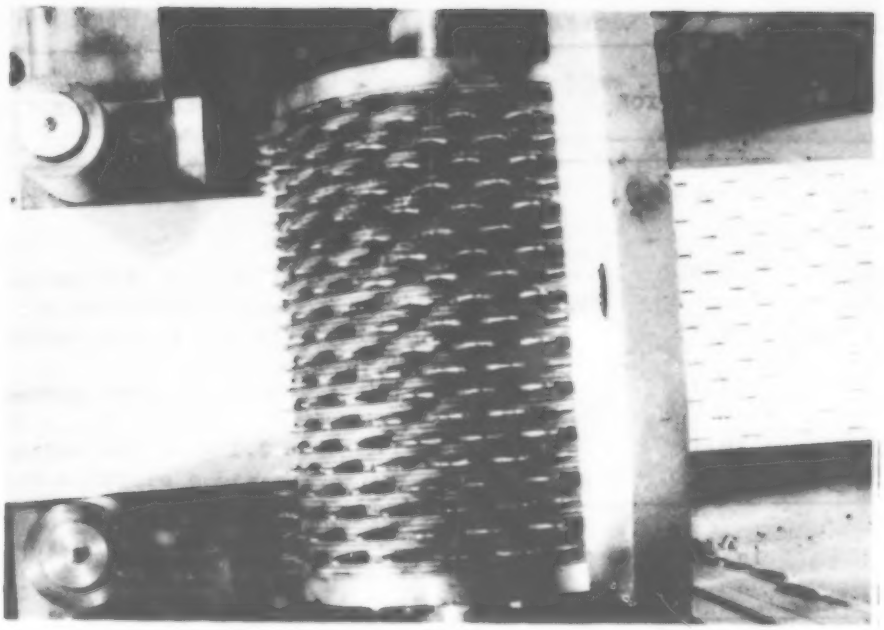

FIGURE 1 Blunt tooth wide spaced incisor in operation.

FIGURE 2 Cross sections of hem-fir (top) and lodgepole pine (bottom) lumber incised and pressure treated with chromated copper arsenate (CCA) then sprayed with a reagent which shows up the treated areas as dark blue and the untreated areas as light orange.

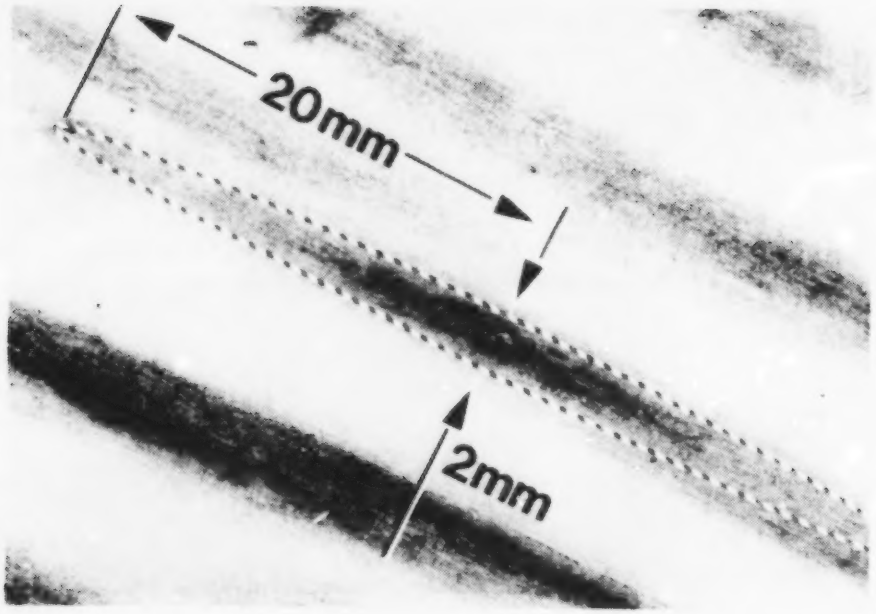

FIGURE 3 Longitudinal and lateral penetration of CCA from a single needle incision in spruce.

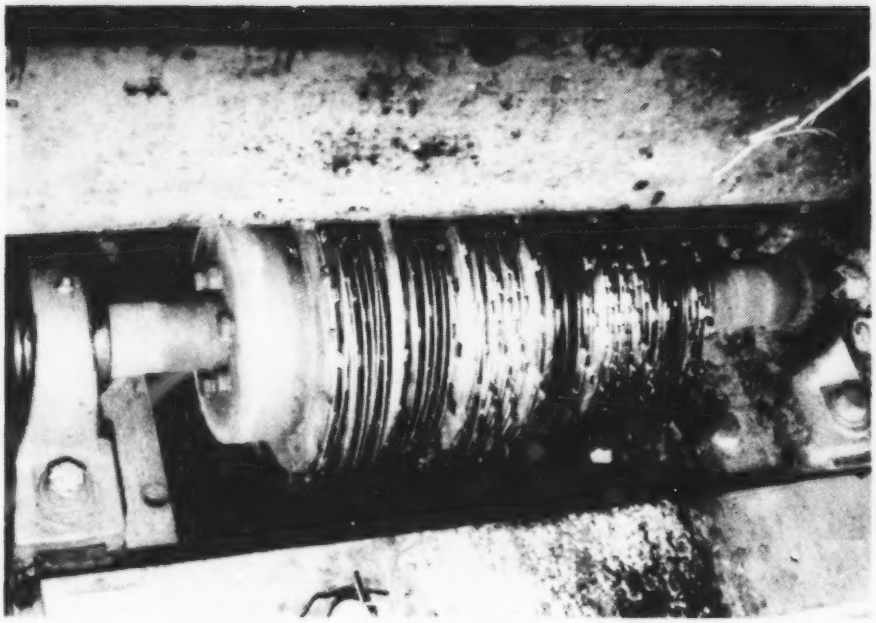

FIGURE 4 Commercially available incisor head showing tooth rings and moveable spacer rings.

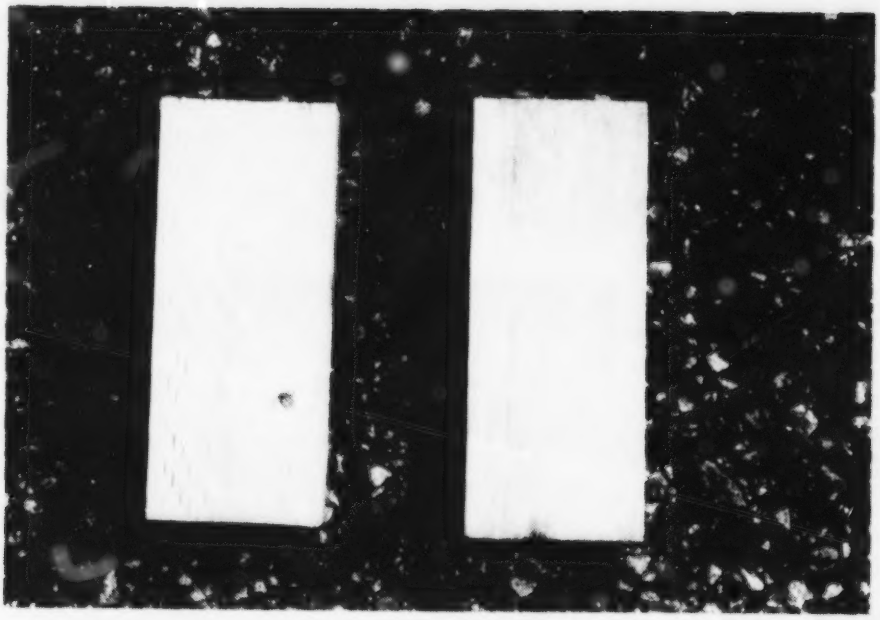

FIGURE 5 Surface appearance of double density dry incised (left) and green incised (right) SPF pressure treated with CCA.

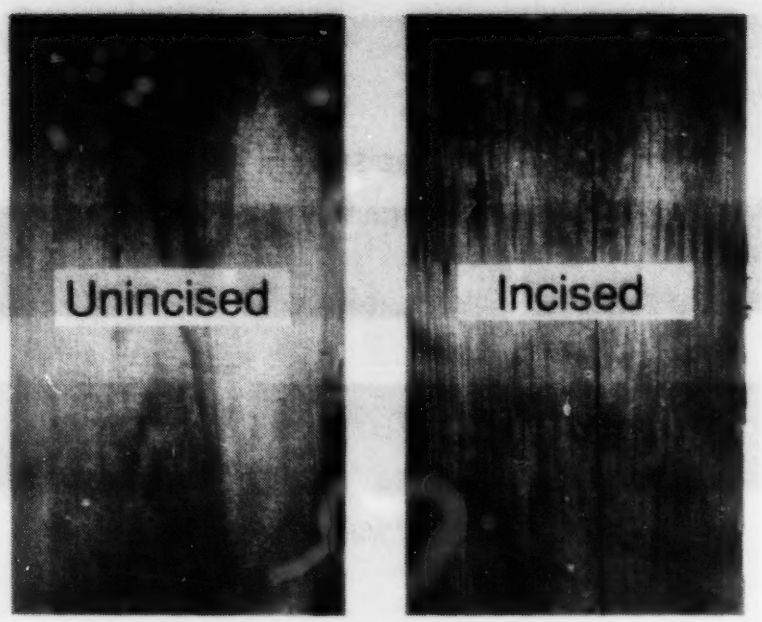

FIGURE 6 Surface appearance of unincised and high-speed high-density incised SPF pressure treated with CCA.

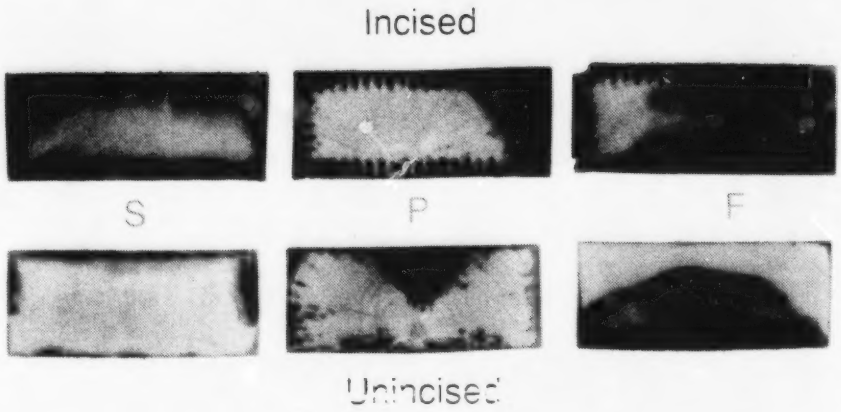

FIGURE 7 Cross sections of high-speed incised and unincised high temperature dried pressure treated SPF.

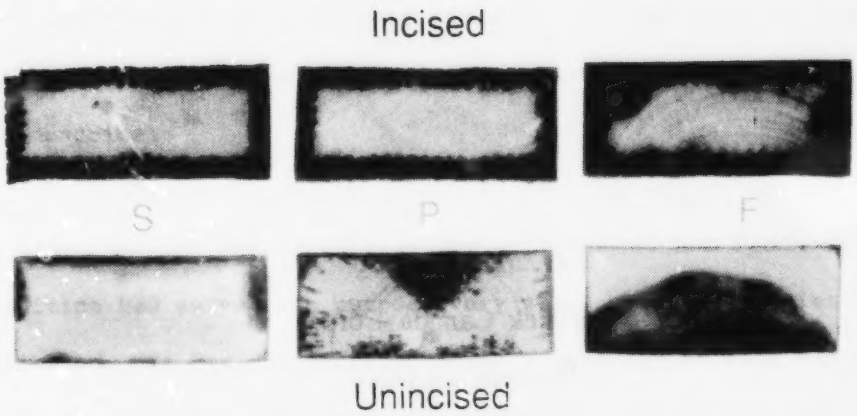

FIGURE 8 Cross sections of high speed incised SPF which was not kiln dried prior to pressure treatment.

TRAINING AND EDUCATION

By

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TRAINING AND EDUCATION

by

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Forintek, Western Laboratory and previously the Western Forest Products Laboratory, has traditionally provided support to the industry in the area of kiln operator training. In recent years this has become a more onerous task due to increasing numbers of applicants, considerably more than could be handled efficiently in a one-week course. A new type of training package has now been developed and it is the elements of this program that I will now describe.

The first thing we did was to reissue our Kiln Operator's Handbook. The previous edition had served its purpose very well, over 4000 copies having been distributed. It ran out of print about a year ago so this was a very good reason to do some upgrading and updating. Since the basics and principles of drying do not change, those sections of the books are similar. We have recognized technological changes and improvements that have occurred in the last 10-15 years including in-line moisture meters, green lumber moisture sorters and computerized kiln controls.

At the same time we have updated our Kiln Drying Correspondence Course. Since its inception in 1975, about 700 people have participated in this activity. Similar to the Handbook, the Course deals with basics and principles of moisture in wood as well as the technological aspects of

drying. The lessons have been increased from 10 to 12 to include advances in drying technology and statistical quality control. The written questions that accompany each lesson and the final written exam have been made more testing. It is expected that successful completion of this course will count towards accreditation in the Council of Forest Industries' Master Sawmiller program.

To supplement material that can only be read or written, we are developing other strategies that will further explain practical applications in kiln drying. A slide-based training video based on shots taken over the years in various mills with examples of both good and bad drying practices is being prepared. A soundtrack will explain the points being made. The video can be used as a supplement to the correspondence course, as part of in-mill training programs, as well as by ourselves as an introduction to regional workshops and seminars on drying.

We do recognize that some training should be done at the mills, so starting this fall and winter we are going to try to institute what we are calling regional workshops where one or more of the lumber drying group at Forintek will come out to specific areas where we have gathered together 15 or 20 people from a number of mills and sit down and look at some real world drying problems, and through the medium of group discussions try to work out how best to solve them. By its very nature, of course, this will be modified to recognize regional topics and we certainly anticipate and will require a significant input from the various industry associations in planning, organizing, and maintaining the industry focus of these

workshops.

In the course of putting together this training material on kiln drying, it became obvious that other areas where we have some expertise should also be included in a comprehensive wood products education program. Consequently, we will be preparing information packages on areas including moisture sorting, saws and saw maintenance, sawmill quality control and anti-sapstain protection.

CURVE SAWING, CANT OPTIMIZATION AND LOG ROTATION

By

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CURVE SAWING, CANT OPTIMIZATION, AND LOG ROTATION

by

S.J. Wang

1. INTRODUCTION

Good afternoon! To complement John Hards' presentation, I will be covering three areas related to curve sawing. First, I would like to present the results of the lumber recovery and lumber size studies conducted jointly by Grande Cache Forest Products and Forintek at Grande Cache Forest Products' sawmill. Second, I would like to discuss the results of a sawmill simulation study that compare the performance of three ways of breaking down a cant. The three ways are the traditional manual linebar edging, computer optimized edging, and curve sawing. Third, I would like to discuss the impact of log rotation on the performance of the three cant breakdown methods.

2. CURVE SAWING PERFORMANCE EVALUATION

2.1 Lumber Recovery

A lumber recovery study was conducted four months after the implementation of curve sawing at Line 1 (small log line) of the mill. At this time, Line

2 had not been converted to do curve sawing. The studies were conducted for both lines. Since the two lines had the same kind of equipment, the results from Line 2 and Line 1 were assumed to represent the performance before and after curve sawing respectively.

The lumber recovery study began by selecting randomly 25 sixteen-foot debarked logs from normal production to fill each of three sort diameter classes for both lines. The sort diameter was defined as the diameter at one foot from the small end of the log. Selection of the logs was done on the same day for both lines to assure similar qualities. The logs were measured for top and butt diameters, maximum sweep, and length. Maximum sweep was defined as the maximum horizontal distance between the edge of the log and a string that was stretched along the edge of the log when the log was manually rotated to the horns sideway position.

The two sets of sample logs selected were run through Line 2 and Line 1 respectively and the resulting lumber was pencil trimmed and pencil edged by a certified grader. Wane and thickness were the only criteria used for trimming and edging. Sufficient gap time was provided between consecutive logs to allow for pencil trimming and edging.

The results of the lumber recovery study are summarized in Table 1 which shows that curve sawing increased lumber recovery significantly. The increases were 16, 8, and 4 percent for the three diameter classes in ascending order, respectively. The percentage gain decreased with increasing log diameter, as generally expected. The declining trend

suggests that there is little advantage in curve sawing logs with sort diameters greater than 10 inches. Furthermore, curve sawing 10-inch cants with circular saws was found to be impractical from a saw maintenance point of view.

2.2 Lumber Size

A lumber size study was conducted before curve sawing was implemented to determine the lumber thickness variation produced by Line 1 machines (log canter, cant canter, and gang edger). Lumber pieces produced from twenty-seven 4-inch cants and 30 6-inch cants were measured for thickness. A similar study was conducted three months after the implementation of curve sawing at Line 1. Another lumber size study was conducted to determine the sawing variation at the twin band. The Forintek baseline lumber size study procedure was slightly modified for taking size measurements (Wang 1986). Briefly, six size measurements (three on each edge) were taken on the thickness of dimension lumber. When the ends were not wany, the measurements at the leading and trailing ends were usually taken at about one inch from the ends. When the ends were wany, the end measurements were taken as close to the ends as possible. The size measurements were analyzed using LUSI (Wang 1986).

The results of all lumber size analyses are summarized in Tables 2 and 3. Table 2 shows that total sawing variation was reduced substantially by curve sawing. Before curve sawing, the curved cants produced at the Line 1 cant canter were straight sawn by the downstream gang edger. If the curved

cant was fed into the gang edger with horns away from the linebar, the leading end of the lumber was usually too thin. If the curved cant was fed into the gang edger with horns against the linebar, the middle of the lumber was usually too thin. Therefore, very high total sawing variation was recorded. After curve sawing, these problems no longer existed, and a smaller total sawing variation was observed. The smaller sawing variation after curve sawing should not be interpreted as the saws were running better during curve sawing. In fact by analyzing the sizes of only the middle pieces from the 6-inch cants, we found that after curve sawing the total sawing variation was more than doubled (Table 2). The total sawing variation of the outside piece (away from the straight edge) remained essentially the same.

A total of 180 pieces of nominal 2-inch lumber (16 to 20 feet long) produced at the twin band from 60 nominal 6-inch cants were measured. The pieces were analyzed separately based on their sweep and positions in relation to the linebar of the twin band. The results (Table 3) indicate that regardless of sweep average lumber size varied by piece position, probably caused by improper setting of the twin band set works. The sawing variations of the second piece were small and were among the best in the lumber industry. The first and third pieces had much larger sawing variations, which could be attributed to the higher sawing variations at the cant canter.

The sawing variations of the straight cants (sweep less than 0.6 inch) and those of the sweepy cants (sweep larger than 0.5 inch) statistically

different indicating that the twin band was doing a good job in curve sawing. If the twin band was not curve sawing well, the sawing variations of sweepy cants would have been much higher similar to those of the gang edger before curve sawing was implemented.

The fact that the twin band curve-sawed 4-sided cants well presents an opportunity for converting existing straight sawing band saw machines into curve sawing ones. Since the feeding system of the twin band consisted of vertical press rolls, horizontal feed rolls and the linebar, adoption of this feeding system to existing secondary band saw machines appears inexpensive and effective. The presence of knot stubs, however, should be dealt with if two sided cants are to be sawn successfully using the concept of curve sawing parallel to one side of the cant. Kenyon (1979) of South Africa patented feeding equipment to minimize the impact of knot stubs and other log surface irregularities on curve sawing.

2.3 Comparison of Three Cant Breakdown Methods

Three cant breakdown methods were compared using SAWSIM, a log bucking and sawing simulation program. Three dimension sawmill models (A,B,C) were used. All sawmill models had a "typical" reducer-twin primary breakdown to produce up to two side boards and a two-sided cant from a log. All side boards were edged with a board edger which positioned the board against a linebar for sawing. The two-sided cant was processed by a chipping-gang. All mills were equipped with an optimizer which selected the best cant width for each log.

The three mill models differed only in the breakdown of the two sided cant. The chipper-gang of Mill A had a shifting linebar infeed (complete with laser-line assist for the operator). The linebar could be shifted by 0.625 inch increments. The chipper-gang of Mill B was equipped with a cant optimizer. For maximum value, the optimizer considered three cant alignment angles: parallel to the least-squares line for one side of the cant, parallel to the least squares line for the other side of the cant , and parallel to a line mid-way between the above two lines. The optimization algorithm simulated that used in the cant optimizer developed by Applied Theory Inc[1]. The cant in Mill C was processed with a curve sawing system which simulated the operation of the curve sawing system installed at Grande Cache Forest Products sawmill at Grande Cache, Alberta, by Ari Sawmill Equipment Ltd[1].

Two log mixes were used in the simulation. Log Mix 1 had 70 SPF logs from northern interior of British Columbia. The average top diameter, sweep, and taper were 6.49 inches, 1.36 inches, and 0.137 inches per foot respectively. Log Mix 2 had 179 primarily Lodgepole Pine logs from the Cariboo region of British Columbia. The average top diameter, sweep, and taper were 5.57 inches, 1.33 inches, and 0.100 inches per foot respectively. The simulation results from these two log mixes were weighted to represent a processing rate of 2800 logs per shift. The

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[1] Use of the suppliers' names does not constitute the endorsement of their products by the author.

weighted log distributions are summarized in Tables 4 and 5.

Simulation runs were designed to compare the efficiency of the three mill models. In these runs logs were assumed to be rotated to the horns down position at the primary breakdown. The results from Log Mix 2 were sorted by diameter, sweep, and taper to gain a better understanding of the differences among the three mill models.

The simulation results are summarized in Tables 6, 7, 8, and 9. For comparison purpose, the lumber and total product value recoveries of the linebar cant breakdown method were used as the basis for calculating the improvements due to cant optimization and curve sawing.

For both log mixes, both cant optimization and curve sawing improved lumber and (abbreviated as value from here on) value recoveries substantially (Table 6).
With Log Mix 1, cant optimization obtained higher lumber and value recoveries than curve sawing. With Log Mix 2, the reverse was true. The average lumber recovery due to curve sawing for the two log mixes was 5.7%, similar to the theoretical 6% found for a typical Swedish sawmill (Sederholm, 1982).

The value recovery increase due to curve sawing outpaced those due to cant optimization in all diameter classes (Table 7). Curve sawing was extremely effective in increasing lumber recovery for logs with top diameter less than 6 inches. The cant optimization alternative scored better than the

curve sawing alternative when the sweep of logs were less than one inch (Table 8). For logs with sweep more than 2 inches, curve sawing had 14.8% value recovery increase while cant optimization had only 0.6%. For logs with small taper, curve sawing was better than cant optimization (Table 9). For logs with higher taper, the reverse was true. The recovery improvement due to curve sawing decreased rapidly with increasing taper of the logs. When taper was greater than 0.15 inch per foot, the lumber recovery from curve sawing dropped below that from conventional linebar sawing, while value recovery maintained a small increase (0.5%).

2.4 Log Rotation

A mill study was conducted to determine the efficiency of manual log rotation. A simulation study, also using SAWSIM with the same three mill models described above, was conducted to see the impact of log rotation on lumber and value recovery. The results obtained from the mill study were used in the simulation study to determine lumber and value recovery losses due to poor log rotation. Only Log Mix 2 was used in this simulation study.

In the mill study, a total of 127 logs were selected from normal production to fill 4 sort diameter classes. Log length varied from 14 to 20 feet. Seventeen of the logs had distinctively two-axis sweep and the other 125 logs had predominately one-axis sweep. The logs were laid on skids in the log yard and visually rotated to the horns down position, which was identified with the letter "T" using spray paint. The logs were also numbered using a different color of paint.

The logs were run through Line 1 at normal operating speed. The log numbers were manually recorded and the logs were video-taped (using two portable video cameras) as they were leaving the two canters. The video tapes were later viewed to measure angle of rotation from the horns down position in degrees.

The measured rotation angles of logs with primarily one-axis sweep are displayed in Figures 1 and 2. Thirty-six percent of the time, the operator was able to turn the logs to within 15 degrees of the horns down position (Figure 1). Forty-three percent of the time, the rotation angle was greater than 30 degrees.

Analysis of variance of the rotation angles showed that rotation angle was negatively related to sweep (Figure 2), but not related to log diameter. In other words, as the sweep of logs increased, the operator became more efficient in turning the logs to the horns down position. This implies that unless log rotation efficiency can be improved, little recovery increase can be expected from curve sawing straight logs (sweep less than 1 inch) and large recovery increase can be expected from curve sawing sweepy logs (sweep more than 2 inches).

The simulation study found that lumber and value recoveries decreased steadily with increasing rotation error (Table 10). If the rotation error was within 15 degrees from the horns down position, less than 1% loss in lumber or value recovery was estimated. If the rotation error was 90

degrees, almost 9% of value recovery was lost.

The lumber or value recovery decreased by 4% for curve sawing (Table 11), when manual log rotation angles (Figure 1) were simulated in sawing Log Mix 2. Smaller decreases were found for cant optimization and linebar sawing. These estimates were, however, subject to errors. First, in the simulation, rotation errors in both clockwise and anticlockwise directions from the horns down position were treated equally. Second, SAWSIM curve sawed logs with same efficiency whether logs were rotated with horns up or down. For example, rotation angles of 30, 60 and 90 degrees had the same effect as 120, 150 and 180 degrees respectively.

3. CONCLUSIONS AND RECOMMENDATIONS

The lumber recovery study found that curve sawing with single arbour circular gang edgers increased lumber recovery by 4 to 16 percent for logs with top diameter from 4 to 8 inches at Grande Cache Forest Products sawmill. A lumber size study confirmed observations that the twin band curve-sawed effectively.

The simulation study found that curve sawing two-sided cants produced the higher lumber and value recoveries for two interior log mixes, when compared to cant optimization and conventional linebar edging. Curve sawing excelled when logs were small (top diameter less than 9 inches),

with less than 0.15 inch/foot taper, and with more than 1 inch of sweep.

Log rotation was found to play an extremely important role in curve sawing. The value loss was almost 9% when rotation angle was off by 90 degrees from the horns down position. Manual log rotation was found to cause a 4 percent lumber recovery loss for one interior log mix.

Canadian mills that have a substantial amount of small sweepy logs, should consider implementing curve sawing not only with infeed systems specifically designed for curve sawing, but also with twin band feeding systems.

To maximize the benefits from curve sawing, log rotation efficiency should be improved.

4. REFERENCES

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3. Sederholm, J. 1982. The influence of crookedness, sorting, and feeding of logs on the volume yield. STFI-meddelande serie A nr 744. Swedish For. Prod. Res. Lab. Stockholm.

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TABLE 1

Before and After Curve Sawing
Lumber Recovery Comparison

Sort Diameter (in.)	Lumber Recovery Increase %
4.3 - 4.8	16
4.8 - 6.3	8
6.3 - 8.2	4

TABLE 2

Before and After Curve Sawing
Size Variation Comparison

Nominal Size	Before		After	
(in.)	No. of Pieces	St (in.)	No. of Pieces	St (in.)
2 X 4	54	0.099	38	0.045
2 X 6	60	0.061	39	0.042
2 X 6[1]	20	0.013	13	0.029
2 X 6[2]	20	0.034	13	0.033

Only the centre pieces were included in the analysis.

Only the outside (third) pieces from the linebar were included.

TABLE 3

Comparison of Size Variation of 2 X 6's by Position from the Linebar of the Twin Band

Sweep (in.)	Factor	Piece Number from Linebar		
		First	Second	Third
<0.6	Number of Pieces	30	30	30
	Sawing Variation, (in.)			
	Within-Board	0.034	0.021	0.042
	Between-Board	0.017	0.009	0.020
	Total	0.038	0.022	0.046
>0.6	Number of Pieces	30	30	30
	Sawing Variation,(in.)			
	Within-Board	0.038	0.019	0.047
	Between-Board	0.014	0.009	0.025
	Total	0.040	0.021	0.055

TABLE 4

Distribution of Log Mix 1 by Diameter and Length

Small End Diameter (in.)	Average Sweep (in.)	Log Lengths (ft.)								
		8	10	12	14	16	18	20	Total	%
4.00-4.99	1.4	80	120	40		120	160	240	760	27.1
5.00-5.99	1.5		160	40		240		200	640	22.9
6.00-6.99	1.3			40		320	120		480	17.1
7.00-7.99	1.3			40		160	40	80	320	11.4
8.00-8.99	1.1					160	40	40	240	8.6
9.00-9.99	1.0					120	40		160	5.7
10.00-10.99	1.6				40	40	40		120	4.3
11.00-11.99	1.2					80			80	2.9
Total		80	120	280	80	1240	440	560	2800	
Percent		2.9	4.3	10.0	2.9	44.3	15.7	20.0		100.0

TABLE 5

Distribution of Log Mix 2 by Diameter and Length

Small End Diameter (in.)	Average Sweep (in.)	Log Lengths (ft.)								
		8	10	12	14	16	18	20	Total	%
0.00-3.99	1.2		45	123	74	38		53	332	11.9
4.00-4.99	1.5		12	76	113	308	53	285	846	30.2
5.00-5.99	1.3		9	63	79	436	20	147	754	26.9
6.00-6.99	1.5			29	89	225		91	433	15.5
7.00-7.99	1.0			32		90	18	41	181	6.5
8.00-8.99	1.3			25	12	61		41	139	5.0
9.00-9.99	1.2				17	35		29	80	2.9
10.00-10.99	1.7							9	9	0.3
11.00-11.99	1.2					16		9	25	0.9
Total			66	347	383	1208	91	704	2800	
Percent			2.4	12.4	13.7	43.1	3.3	25.1		100.0

TABLE 6

Improvements in Lumber and Value Recoveries by Cant Optimization and Curve Sawing

Log Mix	Increase in L. R.		Increase in V. R.	
	Cant Opt.	Curve Saw.	Cant Opt.	Curve Saw.
	%	%	%	%
1	5.7	4.2	5.5	5.2
2	5.2	7.2	4.3	6.1

* L.R. = lumber recovery
V.R. = value recovery

TABLE 7

Effect of Diameter on Improvements in Lumber and Value Recoveries Due to Cant Optimization and Curve Sawing

Dia. Class (in.)	Increase in L. R.		Increase in V. R.	
	Cant Opt.	Curve Saw.	Cant Opt.	Curve Saw.
	%	%	%	%
<6.0	6.6	10.0	5.1	7.6
6.0-8.9	4.0	5.4	3.8	5.0
9.0-12	4.2	4.2	3.8	5.2

* L.R. = lumber recovery
V.R. = value recovery

TABLE 8

Effect of Sweep on Improvements in Lumber and Value Recoveries due to Cant Optimization and Curve Sawing

Sweep Class (m)	Increase in L. R.		Increase in V. R.	
	Cant Opt.	Curve Saw.	Cant Opt.	Curve Saw.
	%	%	%	%
<1.0	6.8	3.5	4.5	2.7
1.0-1.5	5.0	5.9	5.3	6.2
2.0-2.9	1.7	20.6	0.6	14.8

* L.R. = lumber recovery
V.R. = value recovery

TABLE 9

Effect of Taper on Improvements in Lumber and Value Recoveries due to Cant Optimization and Curve Sawing

Taper Class (in/ft)	Increase in L. R.		Increase in V. R.	
	Cant Opt.	Curve Saw.	Cant Opt.	Curve Saw.
	%	%	%	%
<0.085	7.7	11.0	5.7	9.0
0.085-1.499	4.2	6.6	3.3	4.9
1.50 +	0.9	(4.2)	2.7	0.5

* ( ) = decrease
L.R. = lumber recovery
V.R. = value recovery

TABLE 10

Effect of Log Rotation Angle on Curve Sawing Performance

Rotation Angle from Horns Down (degrees)	Loss from Horns Down Position	
	Lumber Recovery	Value Recovery
	%	%
15	0.8	0.7
30	3.7	3.5
45	5.3	5.6
60	7.6	7.4
90	8.4	8.9

TABLE 11

Effects of Log Rotation on Lumber and Value Recoveries for Three Mill Alternatives

Mill	Lumber Recovery (Value Rec.)		Loss from Horns Down Position
	Horns Down	Manual Log Rotation	
A	237.2 (56.0)	232.5 (55.4)	2.0 (1.1)
B	249.5 (58.4)	241.5 (57.1)	3.3 (2.3)
C	254.3 (59.4)	244.5 (57.4)	4.0 (3.5)

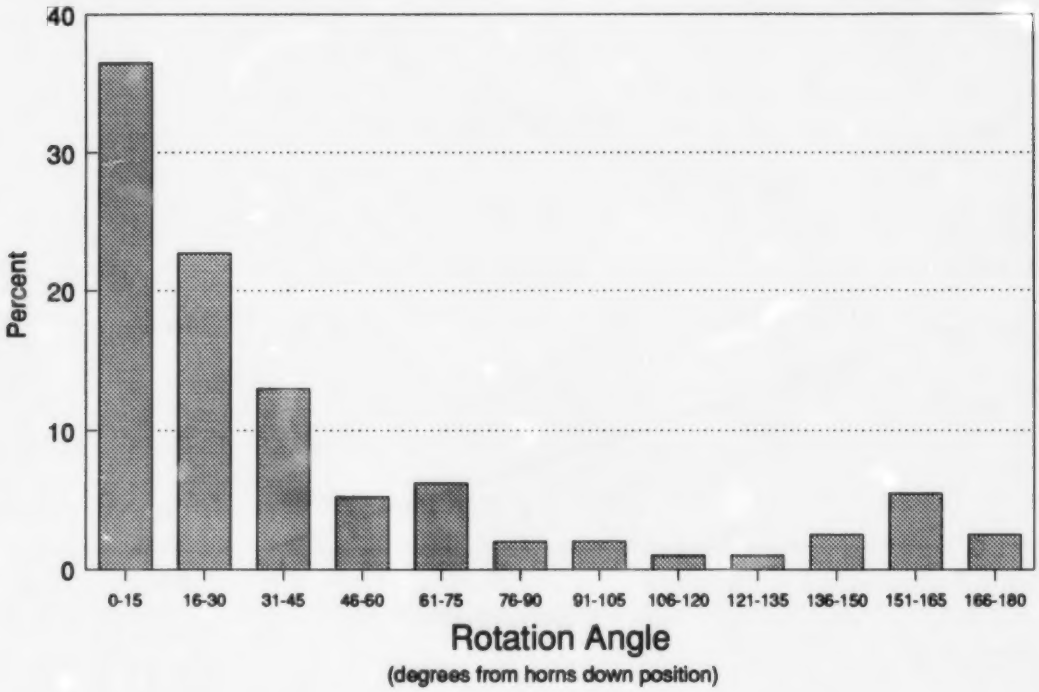

FIGURE 1 Distribution of manually controlled rotation angles for logs with primarily one-axis sweep

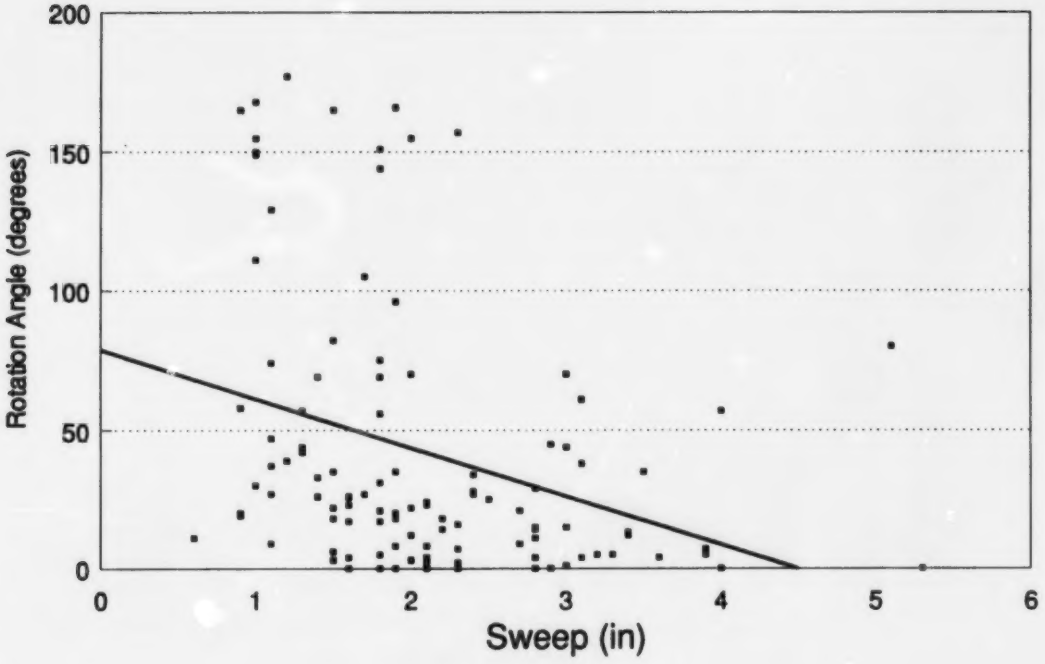

FIGURE 2 Correlation between the amount of sweep and manually controlled rotation angles for logs with primarily one-axis sweep

CURVE SAWING

By

John Hards

Manager, Technical Development

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CURVE SAWING

by

John Hards

I want to start with a little about the history of the Grande Cache sawmill, because with the log quality we obtain from the forest in the region you might wonder why anybody would build a sawmill there. Some of you probably remember there was a competition at that time for the Berland forest. A sawmill was part of the ticket of getting this forest, which was large enough to support a large pulp mill. The Alberta Government wanted to have a sawmill in Grande Cache because they had a mine there, a new instant town, somewhat similar to Mackenzie in northern B.C., and a committment to a lot of people. They wanted to spread the employment base so that the town would survive when the coal market went down.

The management of British Columbia Forest Products agreed to build a sawmill in Grande Cache in return for getting the Berland tract which they required to supply a pulp mill proposed for Whitecourt. The sawmill was built, but unfortunately the recession came and B.C.F.P. was unable to build the pulp mill. After a few years and quite a few studies B.C.F.P. allowed their cutting option to lapse and the timber reverted to the Alberta Government. B.C.F.P. was allocated enough timber to run the sawmill, but the timber turned out to be some of the poorer quality in the

foothills. It is very sweepy and crooked, and presents a difficult conversion problem. Had the pulp mill been built the sawmill might have been alright as it was originally designed because we would have been able to switch logs back and forth and chip the pulp wood, and we would have had reasonably good quality sawlogs to put in the sawmill. Having to process the entire log mix made the mill a marginal operation.

Faced with the situation as it developed, B.C.F.P. started looking at alternatives that might make the mill profitable. They seriously considered converting it into a stud mill, but turning a dimension mill into a stud mill results in an inefficient operation unless you start all over again. The Alberta Government had an interest in the mill's survival, but suggested that a study of alternatives be undertaken prior to any further investment. The study was done by Carroll Hatch using SAWSIM, a sawmill computer simulation program. They measured a sample of trees in detail for sweep, crook, diameter, taper and length, and used this information to characterize the forest inventory. The study showed that with the price of studs at that time we would probably lose more money if we converted to a stud mill. SAWSIM was then used to investigate alternatives. It indicated that by cutting longer lengths, producing MSR, improving machining capabilites in the mill, and installing optimizers recovery and value yields could be improved enough to make the mill profitable.

We had to start looking at what we had there. Optimizers are relatively straight forward. You heard about optimizing the log deck this morning,

and edger and trimmer optimizers are other applications. However, we had canter lines that were a difficult problem. The lines each have a log canter followed in line by a cant canter. These canters have vertical belts that are mechanically centred and the log is fed in between the belts. The canter is set and it chips out a full face on each side of the log. Because of the way they are made neither the log canter nor the cant canter do a very good job of positioning the log. They were designed so that the log would come out of the first canter, be turned 90 degrees, have the two flat faces on the rolls, go in between the second set of belts, be squeezed, go through the second canter and leave you with a four-sided cant. The cant would go further down stream and directly into a gang edger with guided saws. The system actually worked quite well from the point of view of production. You could put a lot of wood through, but the lumber recovery was terrible because these belts just don't do any positioning.

We had to decide what we were going to do with this part of the mill because it is the key to recovery. When Forintek made us aware of curved sawing, and Ari's representative described their product, it looked like something that might fit. We went on a trip to Sweden and saw that the curve sawing certainly works over there. Their logs are what we would consider straight but they still achieve an improvement in recovery from curve sawing.

Figure 1 shows an obvious reason for curve sawing. It shows a sweepy log

for which it is claimed curve sawing provides an improvement of 43% to 58% in recovery because you are able to take advantage of the actual size of the log, rather than reducing its effective diameter as you do when you try to cut a straight cant. In our Grande Cache sawmill the improvement on some logs could be much more than that. If you put this sweepy log against a straight edge and the straight edge is designed with the saws at 1 3/4", then for a 4" diameter log you might recover nothing from it, but with the curved sawing technique you may recover two full length 2X4's.

There are a couple of keys to curve sawing. The first key is the log canter which chips the first two faces. The log has to go in, with the correct rotation, which is controlled by the operator. If he doesn't rotate it correctly curved sawing doesn't work correctly. It is very difficult for the operator to judge the correct rotation because he first has to detect the sweep and then he has to turn the log horns up or horns down to place the sweep in the vertical plane. Most of the time he can do it. The cant is then turned 90 degrees, placing all the sweep in the horizontal plane and the second, or cant canter, can chip along the curve.

The way that curve sawing is accomplished in Sweden was really interesting, but we learned that it is not the only way to do it. They use a diablo roller, which we call an hour glass roll. This works by putting pressure on the cant. In our Grand Cache mill this roller is above, and it pushes down on the cant. The idea is that knots, or poor quality limbing will have very little effect on the rolls. It does have some centering action, and in the cant canter the chipping action comes right

after these rollers, and chips the log on the centre line. That actually works very well, but there is a little problem which I will explain in a minute. Further downstream you have the four-sided cant that was actually straight cut on the log canter, turned 90 degrees then chipped along the curve on the cant canter. On the gang saw, there is a very short straight edge close to the saws and the previous long straight edge is moved back out of the way. A holdover roll keeps the cant tight against the short straight edge. All you are doing is working on a very short part of the curve of each piece, and in a way the saws are really seeing a straight cant. Its almost like feeding the table saws at home where you can actually cut a curve and it works very effectively. This is the same machinery they use in Sweden, however they very often have a saw in the centre. They make a different cutting pattern and have the curved length forced to the centre. They simply take small side boards which we don't want. All we want is 2-inch dimension lumber.

Now the little problem comes in. What we have done in effect is half taper chipping on the log canter and on the cant canter but we are doing full taper sawing on the gang edger. So we are losing some recovery. You have to make a long full face on the cant to make it work properly at the gang saw and you end up chipping a little bit more off than the theoretical ideal. We have some ideas to fix that.

A question that always comes up is what do we tell sawfilers about curve sawing. Ari has a theory that the arc of the curve fits into the clearance between the teeth and the saw blade (Figure 2), and I am sure

this theory is correct. However, we did not change our saws for curve sawing. Ari wanted to put a splitter on to prevent the wood binding at the back end of the saws. We did not do this and I do not feel there have been any related problems but there is a problem of saw binding and it relates to the distance from the infeed holdover rolls to the saws. This distance is very short, about 1", and the cant is moving very fast, probably 350 feet a minute, and you must have the sequencing done so that the leading end of the piece is properly held by the rolls before the cant enters the saws.

Sequencing of the rolls is a very critical timing problem, and occasionally a piece will get into the saws the holdover rolls push it over and put pressure on the sides of the saws which are in the guides and this stretches the leading edge of the saws. That's something that really needs to be watched in future installations.

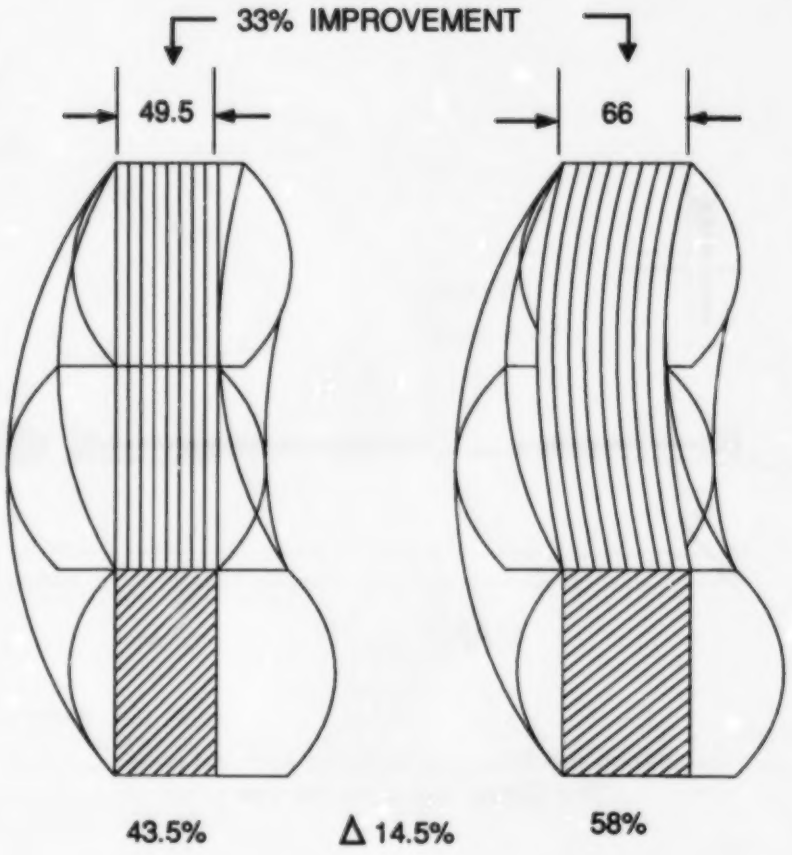
Ari explained to us that it is very important that the positioning of the log is absolutely correct on the log canter where you are making the first two straight cuts. If the face on one side is larger than the face on the other, meaning the log isn't centered properly, on the infeed chain, you are going to have a lot more wane than you want. This is very exaggerated (Figure 3), but it happens in our mill. You can very often have sides (R and L) of different size. This produces a terrific amount of wane on the top, and no wane on the bottom, and you have to trim the pieces. This should not happen if the log canter does its job properly.

We knew that centering the log on the first canter was critical, and we bought a scanning system that looks at where the log is on the chain, and moves the cutting heads very slightly in increments of 10 thousands of an inch. Because of log movement that occurs on the chain from where it is scanned to where it enters the canter we were not able to make that work effectively. We have done away with it for now, and are mechanically centering the log, and log rotation is the key. If the log is not rotated properly, then the tail end is somewhat to one side and causes problems.

Ari claims that 50% better centering and primary breakdown can improve recovery by more than 5%. However, recovery drops if the log is not properly centered. If it is off-centre by 5 millimeters it goes down to 47%, 20 millimeters off centre reduces it to 43%. So curve sawing is an art, and it is critical that the machinery is carefully designed and that everybody who works in the mill really understands what they are trying to achieve.

We have a centering system in front of the cant canter similar to that in front of the log canter, but this second centering system centers the cant, then lets it go. Then the infeed rolls come down on top of it, holding it in place while feeding into the chipping heads. In our mill, because of the original design, we run logs butt first. We didn't want to change that because it meant restructing the log crane and the log decks, but we should have made the changes because it is extremely difficult to center the log fed butt first.

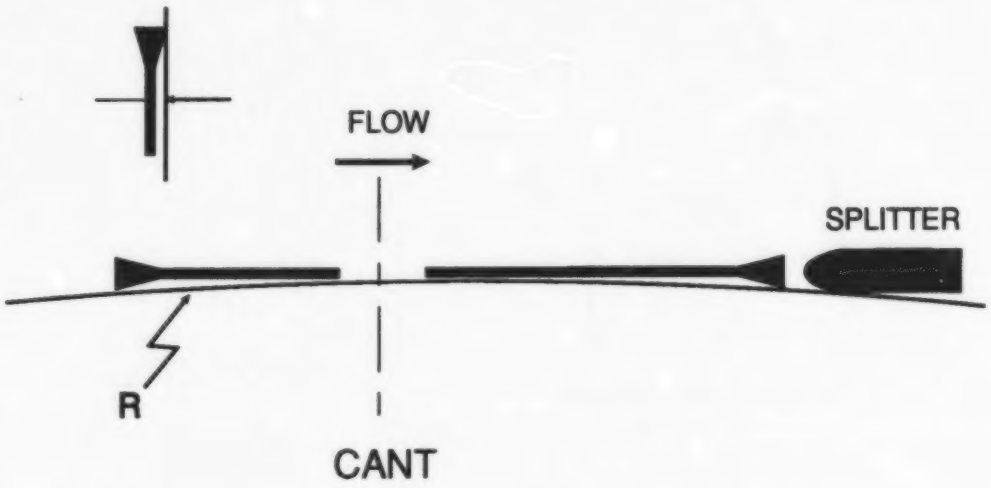
We learned the answers to two questions - one was which way should you turn the horns, horns down; and the other was should logs be fed top first or butt first, and the answer is top first.



LOG DIAMETER = 12 cm
LOG LENGTH = 4 m
TAPER = 4 mm/m
SWEEP = 30 mm

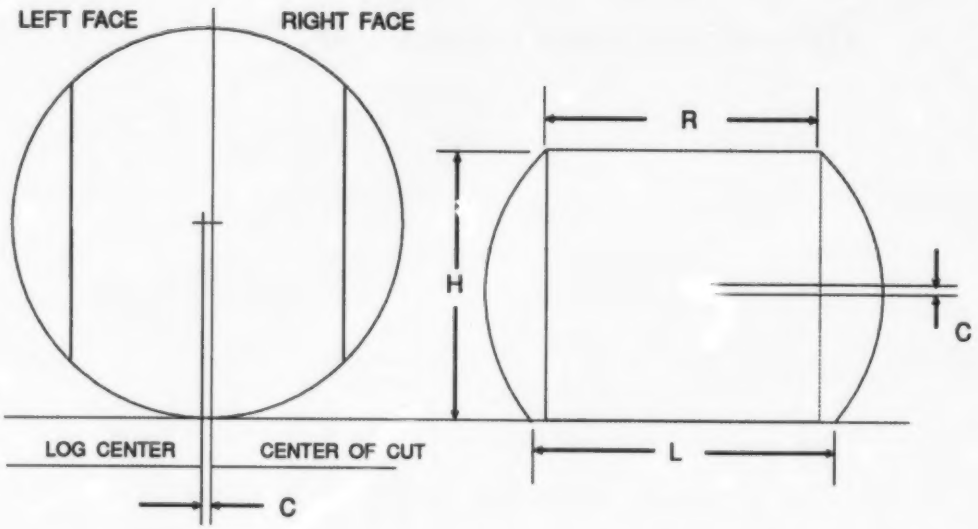
$$\text{YIELD} = \frac{\text{lumber } (m^3)}{\text{log } (m^3)} \times 100$$

FIGURE 1 Improvement in lumber yield from curve sawing



By utilizing the difference between kerf and plate,
"The Curve" can pass the saw

FIGURE 2 Basic curve sawing technique used by ARI



C = CENTERING FAULT
F = FACE WIDTH DIFFERENCE
H = HEIGHT OF CANT
L = LEFT FACE WIDTH
R = RIGHT FACE WIDTH

$$C = \frac{L^2 - R^2}{8 \times H} \qquad F = L - R$$

The face width difference "F" is more than four times the log centering fault "C"

FIGURE 3 Consequence of a log being positioned somewhat off center

TESTING A NEW CIRCULAR SAW GUIDE SYSTEM IN A LARGE PRODUCTION SAWMILL

By

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TESTING A NEW CIRCULAR SAW GUIDE SYSTEM IN A LARGE PRODUCTION SAWMILL

by

E. Kirbach

1. INTRODUCTION

The cutting performance of circular saws has improved substantially in recent years due to splined arbors, reduced wear of saw teeth, optimised tooth geometry, improved grinding techniques, and most importantly, improved guiding. On the average, kerf reductions of more than 0.070 inches have been achieved in many B.C. sawmills. Further kerf reductions of at least 0.020 inches are possible by improved saw guide technology. This represents a potential increase in lumber yield of 2 per cent.

The Flexo guide is a new guide system developed at Forintek Canada Corp. to achieve kerf reduction. Also, it will reduce surface roughness of cut lumber by dampening saw blade vibration which causes back cutting of the saw blade. Most importantly, the new system will allow many sawmill operations to cut with single arbor instead of with double arbors. The use of single arbor machines, eliminates the mismatch line of double arbor cut lumber, which is one of the most serious problems the Canadian sawmill industry presently faces in manufacturing rough lumber for foreign markets. Replacing double arbor with single arbor machines will also substantially reduce saw and saw maintenance costs by reducing the number

of saws by half.

Essentially all circular saw guide systems operated in Canadian sawmills involve only one pair of guide blocks. Only two sawmills use double guide systems, one system has been developed by a Canadian equipment manufacturer and the other system is a foreign development. But these systems provide only marginal improvements in saw performance. One system involves stationary and rigid mounting of the guide blocks which requires very precise alignment of the two guide pairs. Since this alignment precision is not easily achieved in sawmill operations, this double guide system has not substantially improved the cutting performance of gang edgers. The other system involves a floating guide pair which is somewhat more effective than the rigid double guide.

The floating guide system consists of a standard guide pair which is stationary and positions the saw blade on the arbor and a freely floating guide pair on the back side of the saw blade below the work piece. Since both guide pads of the floating guide section are rigidly connected with each other and are mounted on a floating support, this guide system acts primarily as a vibration dampener and less as a reducer of sawing deviation.

The Flexo double guide system has substantial advantages over the other systems. Whereas the system with the floating guide pair reduces sawing deviation by less than half, the Flexo double guide has been found in laboratory experiments to reduce sawing variation by four to six times on

average. Also the new system effectively reduces saw blade vibration and in turn surface roughness of cut lumber.

The Flexo guide system consists of a stationary standard guide pair for positioning the saw blade, and a novel flexible second guide pair which is located above or on the back side of the cut. Figure 1 shows schematically the arrangement of the main and the flexible guide pairs. The flexible guide pair consists of two independently operating guide pads which are spring loaded, preferably by air pressure. A critical feature of the new guide system is the pad mounting which prevents the flexible pads from exceeding the zero line of the running saw when the saw blade tends to deflect against the other guide pad. This is extremely important for thin-kerf saws in cutting knots. The flexible guide pads provide a spring-like support to the saw which reduces the formation of lumps in cutting knots. Lumps, which are non-flat spots in the overall flat blade, are detrimental to the cutting performance of circular saws.

The Flexo flexible guide has been successfully tested in the laboratory. Further work with mill testing is required to introduce it into Canadian sawmills.

Based on laboratory cutting tests, the Flexo guide system has the potential to reduce kerf by 0.015 to 0.050 inches, improve sawing accuracy by 0.010 to 0.030 inches, to significantly increase feed speed and to replace double arbor with single arbor sawing which will eliminate mismatch. Poor sawing accuracy and mismatch are two of the most serious

problems encountered by sawmills in selling lumber to overseas markets. The indicated improvements in sawing performance achieved with the new guide system provides sawmills in B.C. with a potential revenue of up to $4,000 daily.

2. OBJECTIVE

The objective of the project is to design a commercial prototype, and test and optimize it in typical sawmill conditions. The mill test is designed to confirm the laboratory results, to allow for testing of alternate guide configurations, and at the same time, to operate the new guide system on a commercial machine which is one of the most productive and efficient gang edger operations in the Canadian sawmill industry. This commercial gang edger is part of the log break down process at Weldwood of Canada's Flavelle Cedar Sawmill in Port Moody.

3.1 Guide Design

The Flexo guide system was designed to be installed in a production edger equipped with a multiple saw set. The guide pads and their housing were reduced to a size which allows the Flexo guide to be used between saws spaced 1.5 inches apart.

A completely new guide arm was designed to mount the guide on a bar. The mounting allows the guide to be moved on the bar and be locked when it is

in alignment with the standard guide. This guide bar was built to fit into the gang edger. The new guide leads the saw into the cut with the saw rotating against the direction of feed. The guide arms were designed for maximum stiffness to prevent bending. Air supply hoses which provide the air pressure to the pistons carrying the guide pads were machined into the guide arms to avoid damage by fractured wood.

The first sawmill prototype of the Flexo guide was identical to the one built and tested in the laboratory. After the second test in the mill, the guide was modified to apply water lubrication which produces a bearing effect between saw blade and guide. For this, special channels were drilled into the guide arm to conduct water to an outlet located directly in front of the guide pads.

After a third test run, a new mounting device for the Flexo guide was designed to allow more accurate alignment of the double guide system.

3.2 Mill Test Set-Up

The guide system was tested in a high production circular saw gang edger operated with 20 saws mounted on a bottom arbor. The saws were rotated against the feed which is commonly known as counter cutting. The machine cut 6 inch Western red cedar cants at a feed speed of 150 fpm.

The test saws measured 30 inches in diameter, 0.085 inches in blade

thickness and cut a kerf of 0.125 inches. The rotational speed of the arbor was 1800 rpm.

4. RESULTS AND DISCUSSION

Three test runs were performed. In the first test, the guided saws initially performed accurate cuts. However, with time, the cutting accuracy deteriorated and the test had to be terminated to avoid damage to the saws and the guide system. The cause of deteriorating cutting accuracy was analysed and it was concluded that poor alignment and possibly insufficient lubrication accounted for the deteriorating performance.

Alignment between the main guide and the Flexo guide was found to deteriorate significantly when the main guide and the saws were rotated after and not before installing the Flexo guide. In multiple saw operations with a large number of saws, the position of the main guide appears to shift when the saws start to rotate. This shifting can be partly attributed to traces of sawdust between the guide blocks.

In the second test, the Flexo guide blocks were operated with water lubrication. In contrast to the first test, the saws rotated for approximately one minute before the Flexo guide was installed and aligned to the stationery saws. Special care was taken to align the saws accurately by using shims. The saws cut for approximately 20 minutes

before one of the three guided saws hit a rock which caused bending of all test saws. Guided saws respond sensitively to tooth damage since damaged teeth cause excessive saw blade deflection which disturbs the lubrication flow in the guide and therefore the support of the saw blade. Also, the guide pads showed wear and required replacement.

The lumber cut before the problem occurred was very smooth in surface texture. No individual tooth marks could be identified. This implies that the new guide system effectively dampened the vibration of the saw blade. Coupled saw blade and tooth vibration is the major factor causing surface roughness of cut lumber when cutting is performed with sharp saws.

After repairing the guide pads and levelling and tensioning the saws, a third test was carried out. Again the individual Flexo guides were aligned as accurately as possible. Initially, the saws cut accurately but once more began to loose accuracy and the test had to be terminated.

Again, various guiding and sawing parameters were checked to determine the reason for the loss in cutting accuracy. It became evident that the setting of the main guide as practiced by the mill did not provide the necessary tight guiding of the saw blade. Also, the water lubrication of this guide appeared insufficient to obtain a uniform bearing effect. Guiding and lubrication was improved by using slightly thicker saws, which reduced the gap between saw blade and guide pads, and by increasing the water supply to maximize bearing effect between saw blade and main guide. As a result the sawing accuracy improved by 0.020 inches.

Wear on the Flexo guide pads indicated that the accurate initial alignment between main and Flexo guide deteriorated when the saw was rotating. This can be explained by the fact that the stationary saw is never entirely flat due to tensioning or pre-stressing of the saw, but the centrifugal forces flatten the saw when the saw is rotating. This changes the position of the saw blade in the Flexo guide and bends the blade slightly.

This observation suggested a new mounting design for the Flexo guide which has now been developed and will be tested shortly. In essence, the new mounting aligns the Flexo guide while the saw is rotating at its full operational speed and not when the saw is stationary. The mounting also provides other significant advantages. Whereas the alignment of the Flexo guide as performed in the test runs described above took 25 to 30 minutes, the alignment involving the new mounting system requires only seconds and is independent of the number of saws in the sawing machine. Moreover, the new system appears to be readily applicable to shifting edgers where double guiding appeared to be extremely difficult.

Since the gang edger used for these mill tests does not allow cuts to 12 inches in depth, an additional series of cutting tests were carried out to obtain information on the lowest kerf which can be possibly cut in processing 12 inch cants with a single saw. This information is of utmost importance to most Canadian sawmills which sell rough-cut lumber to overseas markets. Overseas customers are extremely reluctant to buy double-arbor cut lumber which as a rule shows mismatch. Presence of

mismatch is considered an indication of poor sawing accuracy. Because of this situation, many sawmills are considering replacing double with single arbor sawing machines. But single arbor machines involving standard guide systems cut extremely heavy kerf when cants of 12 inches are cut. When hemlock cants of 12 inches are sawn with single guided, single arbor saws, for example, the saws normally have kerfs of more than 0.240 inches. With the addition of the Flexo guide, the kerf can be drastically reduced. In cutting unfrozen and unseasoned western hemlock cants of 12 inches in thickness, the Flexo guide allowed a kerf as low as 0.136 inches. Without the Flexo guide and cutting the same kerf, the saw was able to cut only 6 inch cants.

To the author's knowledge, a kerf of 0.136 inches has never been achieved in sawing 12 inch cants with a single circular saw. This kerf is normally considered excellent in cutting 6 inch thick cants with a single saw supported with standard guides. In cutting 12 inch cants with double arbor sawing machines, the kerf is commonly in the range from 0.150 to 0.250 inches with the majority of kerfs being over 0.200 inches.

What is even more impressive for the cutting performance of the Flexo-guided saw is the fact that the kerf of 0.136 inches was cut with a sawing variation of less than 0.010 inches. This is an extremely high accuracy for industry standards. Industrial operations normally have a sawing accuracy of 0.020 to 0.030 inches.

Furthermore, in cutting 6 inch cants with and without the Flexo guide, the

cuts differed widely in cutting accuracy. Whereas the Flexo guided saw showed a cutting accuracy of only 0.002 inches and less, the standard guided saw cut at an accuracy of 0.025 inches (Figure 2).

The excellent sawing results obtained with the Flexo guide used as a second guide support will provide major economic advantages. First, kerf is reduced substantially. Assuming that it is 0.025 inches lower, a mill using the guide increases its recovery by 2%. In a mill producing 500 M fbm per day, this amounts to $2000 per day. Second, a double guided single saw eliminates the mismatch problem which as discussed earlier constitutes a major problem in marketing Canadian lumber in Japan and Europe. Third, double guiding reduces saw costs since only half the number of saws are used in comparison to a double arbor gang edger.

5. CONCLUSIONS

The tests of the new guide system demonstrated that the Flexo guide has to be accurately aligned with the main guide. Accurate alignment was found to be extremely difficult to obtain in the gang edger with the saws in the stationary state. A new guide mounting system which aligns the guides while the saws are rotating at operational speeds without cutting is being developed to obtain the necessary accuracy with a very short period of time for alignment.

The Flexo guide can be operated without water lubrication since the water applied by the main guide is sufficient.

Additional laboratory cutting tests have shown that the Flexo guide has the potential to replace double arbor with single arbor sawing at acceptable kerf. Single arbor sawing eliminates the problem of saw mismatch.

6. RECOMMENDATIONS

Based on the results of this study, the following recommendations are made:

1. Further tests have to be conducted to evaluate the effectiveness of the new self-alignment system for the Flexo guide.

2. The new self-aligning system should be tested for its suitability for guiding shifting edger saws.

3. The potential of the new guide system for converting double arbor into single arbor machines (to eliminate the mismatch problem), should be demonstrated by installing the Flexo guide in a double arbor machine and operating this machine with one arbor only.

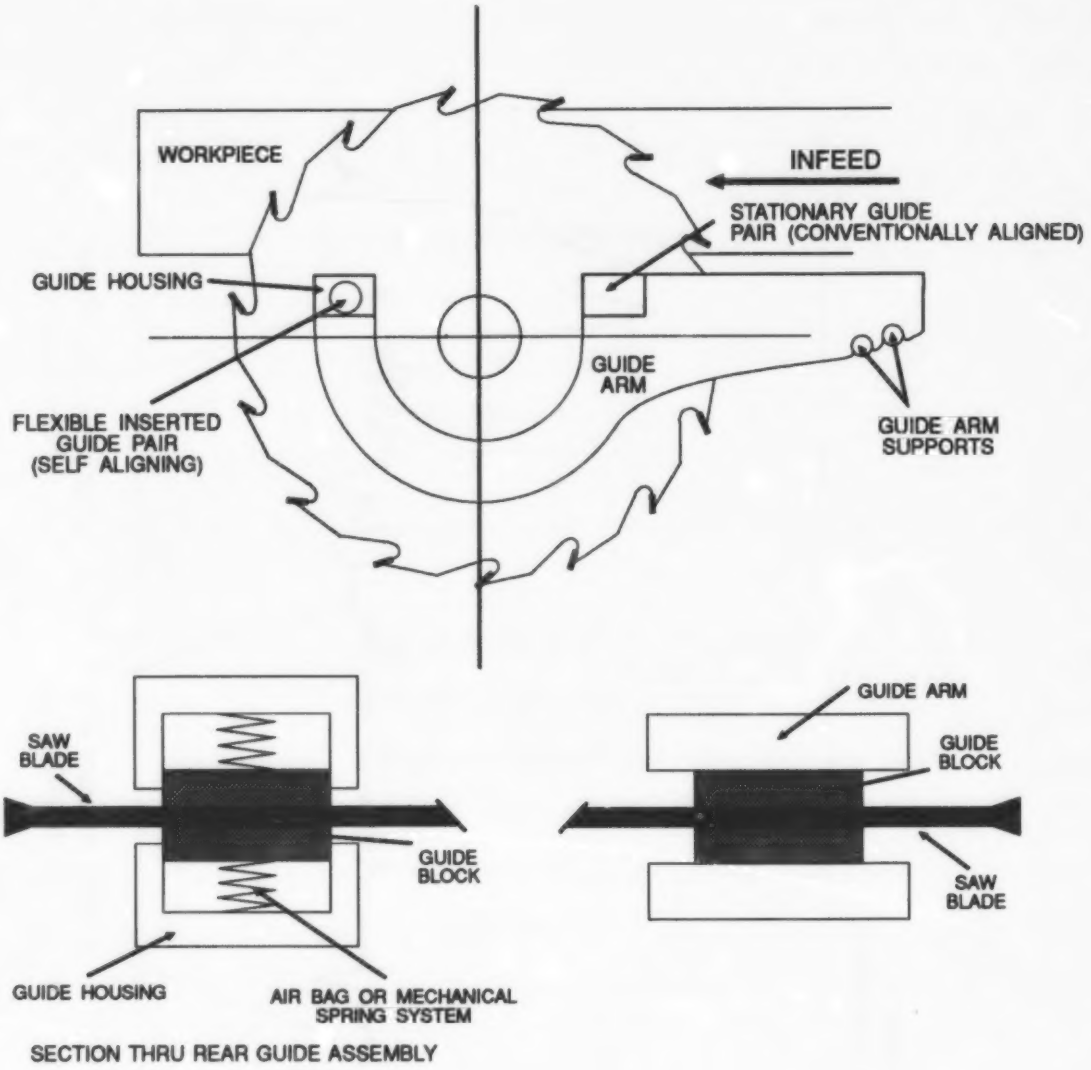

FIGURE 1 Main (stationary) and Flexo (flexible) guide arrangements and cross-sections of main and Flexo guide pairs

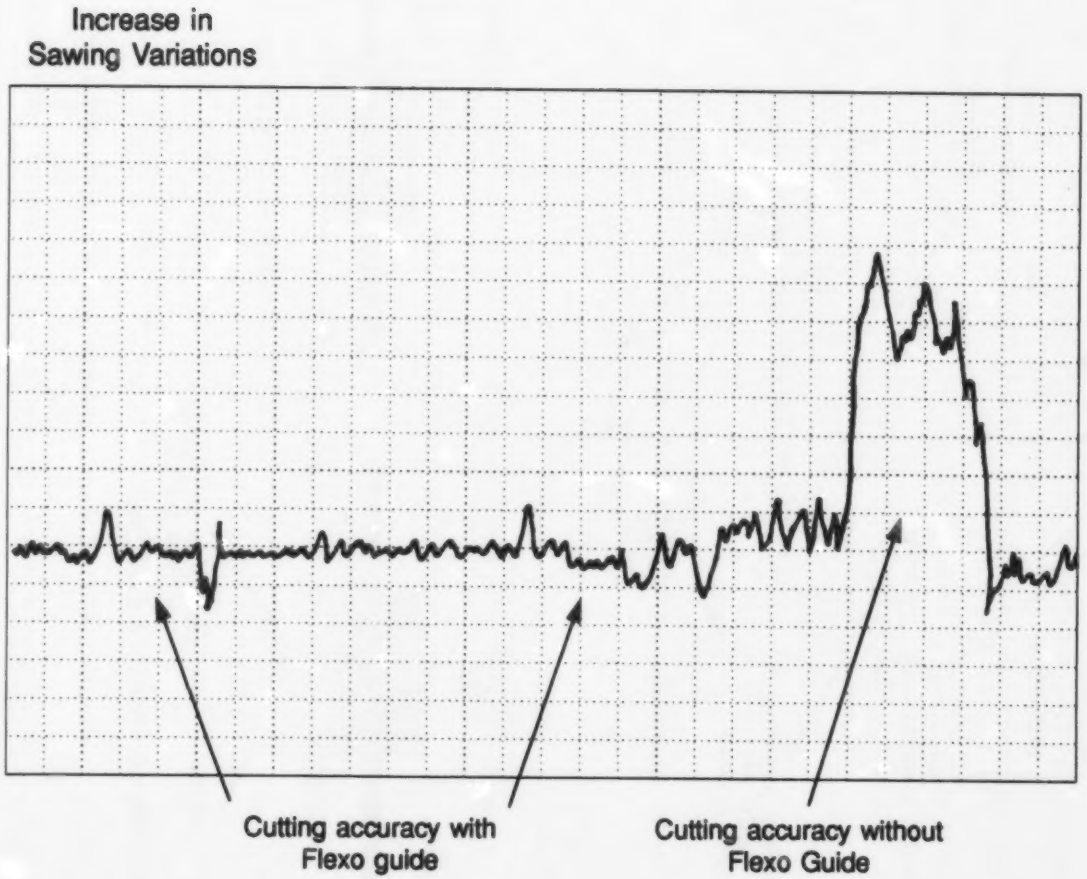

FIGURE 2 Difference in cutting accuracy observed with and without Flexo guide in cutting 6 inch unseasoned hemlock cants

A SAW CONTROL SYSTEM

By

Sita Warren

Research Scientist

Forintek Canada Corp.

Western Division

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Vancouver, B.C.

V6T IX2

A SAW CONTROL SYSTEM

by

Sita Warren

The problems encountered in setting up any type of sensor for monitoring sawing deviations are:

(1) very little room to build any type of holder to accommodate the sensor,

(2) sensors are extremely fragile, therefore, noise and vibration will result in damage.

In order to overcome these difficulties Forintek designed a holder to house the probe and locate it directly on the saw guide.

The sensor used in the application is a Kaman transducer which works on the magnetic principle. This displacement probe has a range of 0 to 0.240 inches. The probe is 50 to 270 thousandth of an inch from the saw blade and 17 thousandth of an inch from the plastic holder. The brass insert in which the probe is mounted is easily removable (Figure 1).

The probe was directly interfaced to an IBM computer which calculated the sawing deviations at various intervals. A light bulb was used to alert the sawyer when the sawing target was exceeded so that corrective action

could be taken. For example, the feed speed could be slowed down. The computer system continually stores data which provide management with the sawing deviations over an 8 hour shift. This is an important factor in ascertaining when the sawing deviations are the greatest.

A mill trial is in progress at the present time at International Forest Products and Dave Fisher has provided the economic benefits he has calculated for his mill (Appendix).

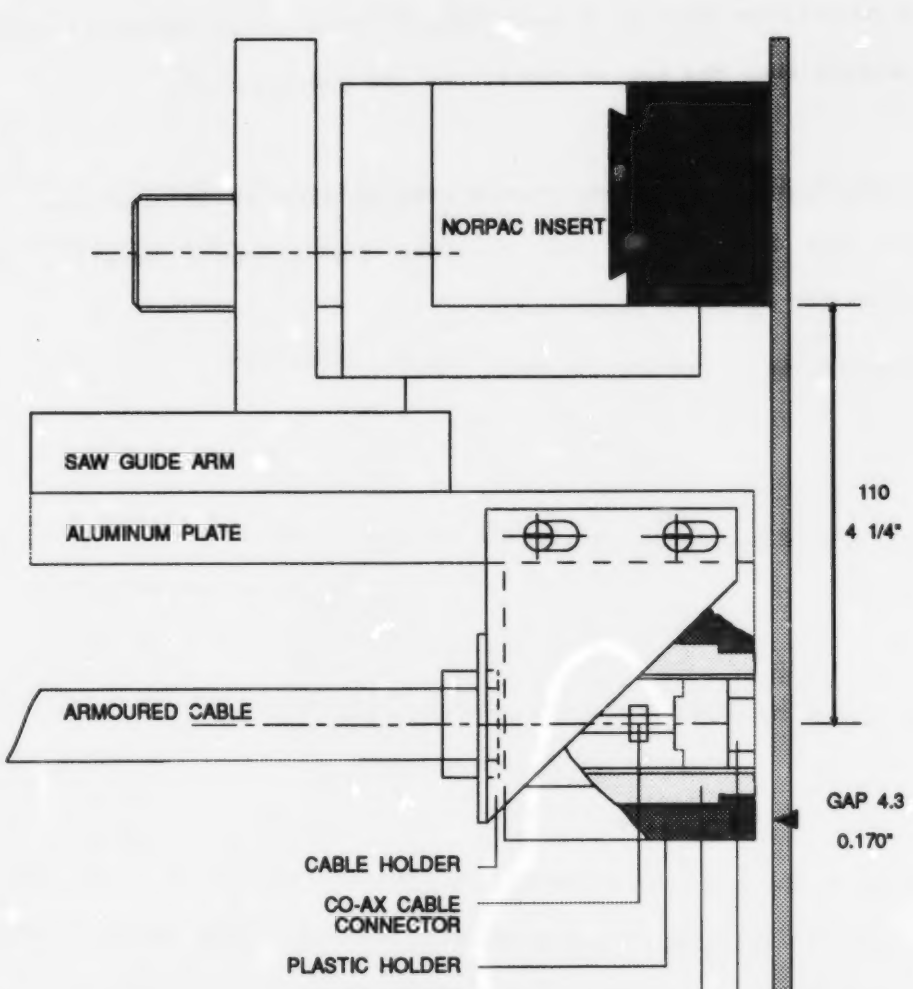

FIGURE 1 Saw deviation sensor holder

APPENDIX

INTERFOR

Silvertree Division

May 2, 1989

Ms. Sita Warren
Research Scientist
Forintek Canada Corp.
6620 N.W. Marine Dr.
Vancouver, B.C.
V6T 1X2

Dear Sita:

SUBJECT: ECONOMIC IMPACT OF SAW MONITORING PROBE ON TWIN

Sawing variations on our twin horizontal resaw have a very significant impact on the lumber recovery of our mill. We presently produce many two and three piece multiples at our headrig for final breakdown at the twin. If we are able to reduce sawing variation at the twin, we can significantly reduce target sizes for these multiples made at the headrig. In addition, an improvement in recovery will also be realized from the slabs being processed.

Reducing the target size that slabs are processed to will improve the recovery in width and length for the resulting pieces.

ECONOMICS

I anticipate a quick reduction in sawing variation from an average of .045" STANDARD DEVIATION TO .030". This improvement will impact our lumber recovery such that we will realize a lumber pickup of 311,850 FBM and a value realization of $187,110 per annum.

Once the operators have developed an understanding of the relationships between feed speeds, quality of material being processed, and sawing variations as recorded and indicated by the probe; I believe a sawing variation of .020" STANDARD DEVIATION is achievable and maintainable.

This further improves our recovery by 207,900 FBM and $124,740 per annum.

..... /2

International Forests Products Limited
P.O. Box 67339, Postal Station 'O', Vancouver, B.C. Canada V5W 3T1 (604)327-9242 Fax (604)327-7422
U.S. Mailing Address: P.O. Box 401, Custer, Washington 98240

Letter to: Sita Warren Cont'd.

Total realizable value from this project, applied to only one machine centre, is $311,850 per annum.

Our intent is to install a comparable system on the headrig as soon as possible. Other machine centres will be considered once the headrig project is complete.

Sita, I hope this information satisfies your requirements in determining a project value for our operation. I have included a list of assumptions used in determining these values.

Yours truly,

Dave Fisher
Production Manager

DF/jn
Encl.

ECONOMIC IMPACT OF SAW MONITORING PROBE

ASSUMPTIONS

- TWIN PROCESSED 1400 PIECES/SHIFT
- 75% OF RECOVERED WOOD FIBRE IS REALIZABLE IN LUMBER FORM
- $600/MBM LUMBER VALUE (CONSERVATIVE AS HIGH PERCENTAGE OF PRODUCTS AT THIS MACHINE CENTRE ARE IN THE UPPER GRADES)
- 495 SHIFTS/YEAR
- TARGET SIZE IS DETERMINED BY: MINIMUM ACCEPTABLE SIZE & (SAWING VARIATION x 3)
- AVERAGE SIZE PIECES AT TWIN = 10" WIDE x 16' LONG

NOTE: THE VALUE OF INCREASED RECOVERY OF CHIPS VS. SHAVINGS WAS NOT CONSIDERED IN THIS CALCULATION